Modified Mallampati Test and Thyromental Distance as a Predictor of Difficult Laryngoscopy in Thai Patients

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Background: *Preoperative evaluation of anatomical landmarks and clinical factors are important in the detection of patients at risk for difficult laryngoscopy. The modified Mallampati test (MMT) and thyromental distance(TMD) are commonly used for this purpose but there are controversies regarding their accuracy.*
Objective: *The objective of the present study was to evaluate the accuracy of MMT and TMD in the prediction of difficult laryngoscopy in Thai patients.*
Material and Method: *1,888 consecutive patients undergoing general anesthesia requiring endotracheal intubation were evaluated preoperatively using the MMT and TMD. The cut-off points for the difficult airway predictors were: Mallampati 3, 4 and TMD less than 6 cm. During direct laryngoscopy, the laryngeal view was graded using the Cormack and Lehane (CL) classification. CL grades III and IV were considered difficult laryngoscopy. Sensitivity and specificity for each airway predictor in isolation and in combination were determined.*
Results: *The present study found Mallampati grade I 1,050 patients (55.6%), grade II 730 patients (38.7%), grade III 104 patients (5.5%), grade IV 4 pateints (0.2%) and TMD less than 6 cm 85 patients (4.5%), TMD more than 6 cm 1,803 patients (95.5%). Difficult laryngoscopy occurred in 60 patients (3.2%). The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for the two airway predictors were: MMT 41.7%, 95.5%, 23.1% and 98.0% and TMD 23.3%, 96.1%, 16.5% and 97.4% respectively. The combination of two predictors with a sensitivity, specificity PPV and NPV were 55.0%, 92.3%, 19.1% and 98.4%.*
Conclusion: *MMT, TMD and their combination are good predictors of difficult laryngoscopy in a Thai population.*

Keywords: *Modified Mallampati test, Thyromental distance, Difficult laryngoscopy*

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Maintenance of a patent airway is a primary responsibility of the anesthesiologist. Closed claimed analysis has found that the vast majority (85%) of airway-related events involve brain damage or death[1]. Benum of, et al reported that one- third of deaths attributable solely to anesthesia had been related to inability to maintain a patent airway[2]. Several studies have assessed on a patient oral cavity examinations including mouth opening, Mallampati classification, head/neck movement, thyromental distance, prognath ability[1-8] prior to anesthesia. These tests have been used singly or in various combinations. Accurate preoperative assessment to predict potential difficulty with intubation can help reduce the incidence of catastrophic complications by alerting anesthesia personnel to take additional precaution before beginning anesthesia and establishing an artificial airway. Nevertheles more accurate prediction of difficulty with intubation might reduce the frequency of unnecessary maneuvers (*e.g.* awake intubation) related to false positive prediction. There is controversy about the accuracy of Modify Mallampati test in prediction of difficult airway. Ramathibodi Hospital uses Modified Mallampati Test (MMT) and Thyromental Distance

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(TMD) as a preoperative test for difficult laryngoscopy evaluation. The authors question these methods for difficult airway prediction. The purpose of the present study was to determine the ability to predict difficult visualized laryngoscopy (DVL) by using Modified Mallampati Test (MMT) and Thyromental Distance (TMD) in Thai patients

Material and Method

The present study was approved by the hospital research ethics committee and written informed consent from all patients. The authors studied 1,888 consecutive ASA I-IV adult patients scheduled to receive general anesthesia requiring endotracheal intubation for all surgery at Ramathibodi Hospital. Exclusion criteria was the patients aged under 15 years, obvious malformation of the airway, edentulous and those requiring a rapid sequence induction. Modified Mallampati classification and thyromental distance were assessed preoperatively. Airway assessment was performed by the attending anesthesiologists or in cases initially assessed by a resident or a nurse validated by the attending anesthesiologist.

Thyromental distance which was measured along a straight line from the thyroid notch to the lower border of the mandibular mentum with the head fully extended was catagoried as < 6 cm or > 6 cm. The visibility of oropharyngeal structures was assessed in the sitting position without phonation as described by Mallampati et al[5]. Assignment was made to class I when faucial, soft palate, pillars and uvula could be visualized, class II when faucial, uvula and soft palate could be visualized, class III when soft palate and base of tongue could be visualized and class IV when only seen the soft palate (Samsoon and Young)[4]. The cut-off point for the difficult airway predictors were Modified Mallampati class III-IV and thyromental distance < 6 cm.

The optimal head and neck was positioned for intubation. Induction and muscle relaxation agents were used. The laryngeal view was assessed with rigid laryngoscopy by anesthesia personnel, forceful anterior elevation of the laryngoscope blade use of a preferred blade by an experienced laryngoscopist. The routine practice during the present study was to attempt initial laryngoscopic visualization by using Mc Intosh blades which was generally used when difficulty was not encountered or anticipated.

The laryngeal view was classified according to the method of Cormack and Lehane[3] as grade I when there was full view of the glottis, as grade II when there was partial view of the glottis or arytenoids, as grade III when there was only epiglottis visible, as grade IV when there was neither glottis nor epiglottis visible. grade III and IV laryngeal views were considered to represent difficult laryngoscopy (and as the conditions for difficult intubation of the trachea)[6,9,10].

Confirmation of successful intubation was by bilateral auscultation over the lung fields or/and capnography.

Statistical analysis

Sample size of 1888 patients was calculated from the formula:

$$n = \frac{Z^2 P (1-P)}{d^2}$$

where n = number of difficult laryngoscopy patients

Z value (1.96 for 95% confidence level)

P = probability of expected sensitivity (Mallampati = 0.33[9]/thyromental distance = 0.16[6])

d = confidence interval (0.05)

Prevalence of difficult intubation = 18%[9]

The authors used Microsoft excel 2007 to collect data. Univariate analyses were performed to assess the association of each airway predictor to DVL. Chi-square analyses were used. Sensitivity, specificity, and positive predictive value were obtained and compared amongst isolated predictors. The combinations of predictors were formulated. Likewise, the sensitivity, specificity, and positive predictive value were obtained and compared amongst the combinations. Demographic and airway predictors were entered into a multivariate linear logistic regression analysis, stepwise method to determine dependent predictors of laryngoscopic view (LV). Coefficients and p-values were obtained for dependent predictor derived. The data were analyzed using the statistical package for SPSS version 11.0.

Results

1,888 patients were studied. Patients' age, body build and ASA physical status are shown in Table 1. There were 649 (34.4%) males and 1,239 (65.6%) females. There were 1,050 (53.6%) MMT grade I, II, III, IV 1,050 (53.6%), 730 (38.7%), 104 (5.5%), 4 (0.2%) patients respectively. 85 patients have TMD < 6 cm. DVL was observed in 60 (3.2%) patients. There was no failed intubation. Laryngoscopy grade III was present in 56 (3.0%) and grade IV in 4 (0.2%) patients. The optimal laryngeal view was obtained using the MacIntosh blade in 84.2% of the cases.

The sensitivity, specificity, positive predictive value and negative predictive value of the MMT were 41.7%, 95.5%, 23.1% and 98.0% respectively. The TMD had a sensitivity of 23.2%, a specificity of 96.1%, positive predictive value of 16.5% and negative predictive value of 97.4%. The combination of the two tests increased the sensitivity to 55.0% but decreased the specificity to 92.3%, the positive predictive value to 19.1% and the negative predictive value to 98.4% as in Table 2.

Compared to Mallampati grade I, when the cut-off point of DVL was the MMT II-IV. The sensitivity, specificity, positive predictive value and negative predictive value were 83.3%, 56.9%, 6.0%, 99.0% and the combination with the TMD were 88.3%, 56.5%, 6.2% and 97.5% as in Table 3.

Table 1. Demographic data

	Number of patients	Percent
Age (year)		
15-29	252	13.3
30-44	504	26.7
45-59	618	32.8
60-74	398	21.1
> 75	116	6.0
Body built		
Thin	81	4.3
Normal	1,601	84.8
Obese	204	10.8
Morbid obese	2	0.1
ASA physical status		
1	378	20.0
2	994	52.7
3	442	23.4
4	73	3.9
5	1	0.1

Logistic regression

Logistic regression showed that MMT, TMD and height were dependent predictors of LV as Table 4 and the correlation was predicted LV = 0.742 + 0.227 MMT-0.229 TMD + 0.005 height (cm), when TMD = 1, 2 (1 = TMD < 6 cm and 2 = TMD $\geq$ 6 cm), $p < 0.05$.

Discussion

The risk for difficulty with direct laryngoscopy increases in the presence of multiple specific anatomical abnormalities[11-14]. Several studies used Mallampati or modified Mallampati in combination of anatomical

Table 2. Sensitivity, specificity, positive predictive value, negative predictive value, true positive, true negative, false positive and false negative of the three airway predictors

Airway predictor	Sensitivity	Specificity	Positive predictive value	Negative predictive value	True positive	True negative	False positive	False negative
MMT (III-IV)	41.7	95.5	23.1	98.0	25	1,745	83	35
TMD < 6 cm	23.3	86.1	16.5	97.4	14	1,757	71	46
Combined MMT + TMD	55.0	92.3	19.1	98.4	33	1,688	140	27

MMT = modified Mallampati test, TMD = thyromental distance

Table 3. Sensitivity, specificity, positive predictive value, negative predictive value, true positive, true negative, false positive and false negative of the three airway predictors when the cut-off point of MMT were II-IV

Airway predictor	Sensitivity	Specificity	Positive predictive value	Negative predictive value	True positive	True negative	False positive	False negative
MMT (II-IV)	83.3	56.9	6.0	99.0	50	1,040	788	10
Combined MMT+TMD	88.3	56.5	6.2	97.5	53	1,032	796	7

MMT = modified Mallampati test, TMD = thyromental distance

factors for predicting difficult direct laryngoscopy. These studies showed there was low sensitivity and specitivity when using only a single test[6,13-16]. The ideal method for preoperative airway assessment should have high sensitivity and specificity and result in minimal false positive and false negative predictions. While a false positive outcome may result in a greater expenditure of time or cause inconvenience (*e.g.* setting up a fiberoptic bronchoscope). The outcome of false negative, which means unpredicting difficult larynxgoscopy and intubation, could be causing major morbidity and mortality.

The incidence of DVL in the present study was 3.17% and was in concordance with the study by Crosby et al, which reported an incidence of 1.5 to 8.5%[17]. The wide variation in the incidence of DVL depends on various factors of the study, such as lack of uniformity in describing or grading laryngeal views, head position, degree of muscle relaxant, type or size of laryngoscope blade or anesthesiologist' skill.

In the present study, it was found that the MMT was a more useful single predictor than the TMD with a sensitivity, specificity and positive predictive value of 41.7%, 95.5%, 23.1% respectively. These results are similar to the studies done by Tse et al and Merah et al[8,10]. Mallampati reported a sensitivity of 53% and a positive predictive value of 93%, however, repeated studies have not obtained this high positive predictive value[5,8,10]. The wide range of results has been attributed to inter-observer variability as reported by Karkouti et al[18].

The TMD had a low sensitivity of 23.2% in the present study. Tse et al and Merah et al[8,10] reported similarly low sensitivity of 32% and 15% respectively. However the combination of two tests increased the sensitivity to 55% at the expense of lowering the specificity and positive predictive value. If the authors used the cut-off point of DVL were MMT II-IV and TMD < 6 cm, the MMT was useful for screening test with a sensitivity of 83.3%. This suggests that the MMT grade I can predict the easy visualization of the larynx.

While difficulty with visualization of the larynx, the combination of MMT and TMD were useful for prediction and it is the most common combination used in the prediction of difficult laryngoscopy (Table 5).

Logistic regression showed that MMT, TMD and height were significant dependent predictors of DVL with p-value < 0.05. Additionally, the coorrelation of these predictors can be made as this equation:

Predicted LV = 0.742 + 0.227 MMT - 0.229 TMD + 0.005 height (cm)

when TMD = 1, 2 (1 = TMD < 6 cm and 2 = TMD ≥ 6 cm), $p < 0.05$.

As equation above the result of predicted laryngoscopic is calculated when the airway predictors are subtituted.

Table 4. Logistic regression showing the dependent predictor of DVL

Predictor	Unstandardized coefficients	Standardized coefficients	p-value
MMT	0.742	0.278	0.002
TMD	-0.299	-0.125	0.000
Weight	0.000	0.004	0.881
Height	0.005	0.073	0.002

MMT = modified Mallampati test, TMD = thyromental distance

Table 5. Comparison of DVL predictor reported in the literature

Source (n, incidence)	Test and criteria	Sensitivity	Specificity	Positive predictive value
Mallampati[5]	MMT ≥ 3	50	84	93
(210, 13%)				
Tse et al[8]	MMT ≥ 3 & TMD ≤ 7 cm	5	99	38
(471, 13%)	MMT = 3 & TMD ≤ 7 cm	21	92	88
Merah et al[10]	MMT ≥ 3 & TMD ≤ 6.5 cm & II G ≤ 4 cm	84.6	94.6	35.5
(380, 3.4%)	MMT ≥ 3 & TMD ≤ 6.5 cm	76.9	96.7	45.5
Present study	MMT ≥ 3 & TMD ≤ 6 cm	55	92.3	19.1
(1,888, 3.2%)	MMT ≥ 2 & TMD < 6cm	88.3	56.5	6.2

DVL = difficult visualization of the larynx, MMT = modified Mallampati test, TMD = thyromental distance, IIG = inter-incisor gap, n = number of patients studied

Conclusion

Modified Mallampati test, thyromental distance and their combination are good predictors of difficult laryngoscopy in Thai patients.

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การตรวจ Mallampati และการวัดระยะระหว่างกระดูกธัยรอยด์ถึงปลายคางเป็นปัจจัยที่ทำนายความยากของการดูกล่องเสียงในผู้ป่วยไทย

วิชัย อิทธิชัยกุลฑล, สุวรรณา ชั้นประดับ, ศักดา อำนวยเดชกร, นิรมล อารยเจริญวงศ์, นภัสวัต ปวโรภาส, วิไลลักษณ์ วงษ์คำ

ภูมิหลัง: *การตรวจร่างกายทางกายวิภาค เพื่อนำมาประเมินความยากของการใส่ท่อหายใจมีหลายวิธี Modified Mallampati test (MMT) และ thyromental distance (TMD) เป็นเครื่องมือที่นิยมนำมาใช้ประเมินการยากของการใส่ท่อหายใจแต่ก็มีข้อถกเถียงกันมากว่า MMT จะสามารถใช้ประเมินความยากของการใส่ท่อหายใจ ได้จริงหรือไม่*

วัตถุประสงค์: *การศึกษานี้มีวัตถุประสงค์ที่จะประเมินความถูกต้องของ MMT และ TMD เป็นเครื่องมือในการประเมินความยากของการใส่ท่อหายใจ*

วัสดุและวิธีการ: *ทำการศึกษาในผู้ป่วย 1,880 ราย ที่มารับการให้ยาระงับความรู้สึกแบบทั่วไปและใส่ท่อช่วยหายใจ โดยได้รับการประเมิน MMT และ TMD ก่อนผ่าตัด ถ้าผู้ป่วยมี MMT มากกว่า 2 และ TMD น้อยกว่า 6 เซนติเมตร ถือว่ามีโอกาสที่จะใส่ท่อหายใจยาก และประเมิน laryngoscopic view ด้วย Cormack และ Lehane (CL) classification ถ้า CL grade III, IV ถือว่ามีความยากในการใส่ท่อหายใจ*

ผลการศึกษา: *พบว่า MMT grade I-IV คิดเป็นร้อยละ 55.6, 38.7, 5.5, 0.2 ตามลำดับ ส่วน TMD น้อยกว่า 6 เซนติเมตร คิดเป็นร้อยละ 4.5 และมากกว่า 6 เซนติเมตร คิดเป็นร้อยละ 95.5 ผู้ป่วยที่ใส่ท่อหายใจยากมี 60 ราย คิดเป็นร้อยละ 3.2 การใช้ MMT และ TMD ประเมิน sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) คิดเป็นร้อยละ 41.7, 95.5, 23.1, 98.0 และ 23.3, 96.1, 16.5, 97.4 ตามลำดับ เมื่อนำ MMT และ TMD มาประเมิน sensitivity, specificity, PPV, NPV มีค่า 55.0, 92.3, 19.1, 98.4 ตามลำดับ*

สรุป: *ผลการศึกษาพบว่า modified Mallampati test (MMT) และ thyromental distance (TMD) และ MMT ร่วมกับ TMD เป็นเครื่องมือที่เหมาะสมในการประเมินความยากของการใส่ท่อหายใจได้ดี ในผู้ป่วยไทย*