

# An Assessment of the Ratio of Height to Thyromental Distance compared to Thyromental Distance as a Predictive Test for Prediction of Difficult Tracheal Intubation in Thai Patients

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**Background and rationale:** Preoperative evaluation is important in the detection of patients at risk for difficult tracheal intubation. Thyromental distance (TMD) is often used for these purposes, but its value as an indicator for difficult intubation is questionable, as it varies with patient size and body proportions. The purpose of the present study was to evaluate and compare the accuracies of the ratio of patient's height to TMD (ratio of height to TMD = RHTMD) and TMD alone in the prediction of difficult tracheal intubation in Thai patients.

**Material and Methods:** The authors collected data on 382 consecutive patients scheduled to receive general anesthesia requiring endotracheal intubation for elective surgery. Thyromental distance and RHTMD were evaluated preoperatively. Difficult intubation was defined in the present study by Cormack and Lehane grade 3 or 4. The optimal predictive value was chosen using a receiver operating characteristic (ROC) curve. The areas under the ROC curves (AUC) of TMD and RHTMD were compared to determine the performance of the different predictive tests used. The sensitivity, specificity, and positive and negative predictive values of each of the predictive tests were calculated according to standard formulae.

**Results:** Difficult intubation occurred in 42 patients (10.9 %). The predictive advantage of RHTMD has a similar specificity with improved sensitivity in comparison with TMD. The AUC of RHTMD was significantly greater than the AUC of TMD ( $p = 0.00$ ). The authors concluded that RHTMD had better accuracy in predicting difficult intubation than TMD.

**Keywords:** Laryngoscopy, Difficult, Predictive test

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Failure in managing the airway is the most significant cause of morbidity and mortality in anesthetized patients<sup>(1)</sup>, and difficult intubation is reported in 1.5-13% of patients<sup>(2-11)</sup>. Preoperative evaluation is important in the detection of patients at risk for difficult airway management. Anatomical landmarks and clinical factors associated with difficult airways have been noted, but it is still questioned whether true prediction is possible and which variables should be chosen for evaluation<sup>(2,3,12-15)</sup>.

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Several studies<sup>(2,4-5,16)</sup> have described prediction schemes with a single risk factor, risk factors used in combination, or a multifactorial index. However, one of the tests proposed to predict difficult intubation, thyromental distance (TMD), varies with patient size.<sup>(8)</sup> TMD has been adjusted for patient height (ratio of the patient's height to TMD: RHTMD) for predicting difficult intubation<sup>(17)</sup>. However, the RHTMD has been tested only in Caucasians. The purpose of the present study was to evaluate the capability the ratio of the patient's height to TMD (RHTMD) compared to TMD for predicting difficult intubation in Thai patients.

## Material and Method

Approval was obtained from our Ethics committee before commencing the present study, and all patients gave written informed consent. The authors studied 382 consecutive ASA I-II adult patients scheduled to receive general anesthesia requiring endotracheal intubation for elective orthopedic, urologic, abdominal and gynecological surgery. Patients aged under 18 yr, obvious malformations of the airway, edentulous and those requiring a rapid sequence induction or an awake intubation were excluded from the present study. Edentulous patients were excluded to avoid the introduction of a variable that might have independently affected the predictability of difficult laryngoscopy.

Preoperative airway assessment was performed for all patients by the same anesthesiologist in order to avoid interobserver variability. Utilizing a rigid ruler, TMD was measured as the straight distance between the thyroid notch and the lower border of the mental prominence, with the neck fully extended and the mouth closed. The authors also assessed mouth opening, interincisor gap, modified Mallampati classification, height, body weight and neck movement.

Each patient was routinely monitored during the entire procedure by electrocardiography, pulse oximetry, and non-invasive blood pressure.

After preoxygenation, all patients were anesthetized using standard agents including midazolam 0.03 mg/kg, fentanyl 1-2 ug/kg, and propofol 2.5 mg/kg, and then paralyzed using atracurium to facilitate orotracheal intubation. The patients were ventilated by mask with 100% oxygen. Laryngoscopy was performed after the loss of the fourth twitch of the train-of-four. The head of the patient was placed in the "sniffing" position with a Macintosh Number 3 laryngoscope blade, by a nurse anesthetist who had ten years of experience.

Glottic visualization was assessed using the modified Cormack and Lehane classification without external laryngeal manipulation<sup>(18)</sup>. This classification involves four grades of glottic visualization: grade I corresponds to complete visualization of the vocal cords, grade II to visualization of the inferior portion of the glottis, grade III to visualization of only the epiglottis, and grade IV to a nonvisualized epiglottis. External laryngeal pressure was permitted after evaluation for the insertion of the endotracheal tube.

Difficult intubation was defined in the present study by using Cormack and Lehane grades 3 and 4.

The preoperative assessment data and the laryngoscope findings were used together to evaluate the accuracy of the two tests (TMD, RHTMD) in predicting difficult intubation. The sensitivity, specificity, and positive and negative predictive values of each of the predictive tests used were calculated according to standard formulae. In addition, receiver operating characteristic (ROC) curves were used to judge the discrimination ability of various variables to predict difficult intubation. The area under a ROC curve represents the probability that a randomly chosen patient with difficult intubation is correctly assigned a higher risk based on preoperative evaluation than a randomly chosen patient without difficult intubation.

A receiver operating characteristic plot was obtained by calculating the sensitivity (true positive fraction) and specificity (true negative fraction) of every observed data value (cut-off value), and plotting sensitivity against 1-specificity (false positive fraction). A corresponding p value of < 0.05 would indicate that the AUC was greater than would be observed by chance alone.

The AUC of TMD and RHTMD were compared to evaluate the performance of the different predictive tests. In addition, the ROC curves were used to identify the optimal predictive cut-off points for each test. The optimal predictive cut-off point is the point on the ROC curve which is nearest (unweighted distance) to the ideal point (sensitivity = 100%; false positive = 0%).

## Results

A total of 382 patients were included in the present study. Laryngoscopies were possible for all patients and there was no failed intubation. The demo-

**Table 1.** Demographic data of patients and distribution of laryngoscopic view (mean  $\pm$  SD) (n = 382)

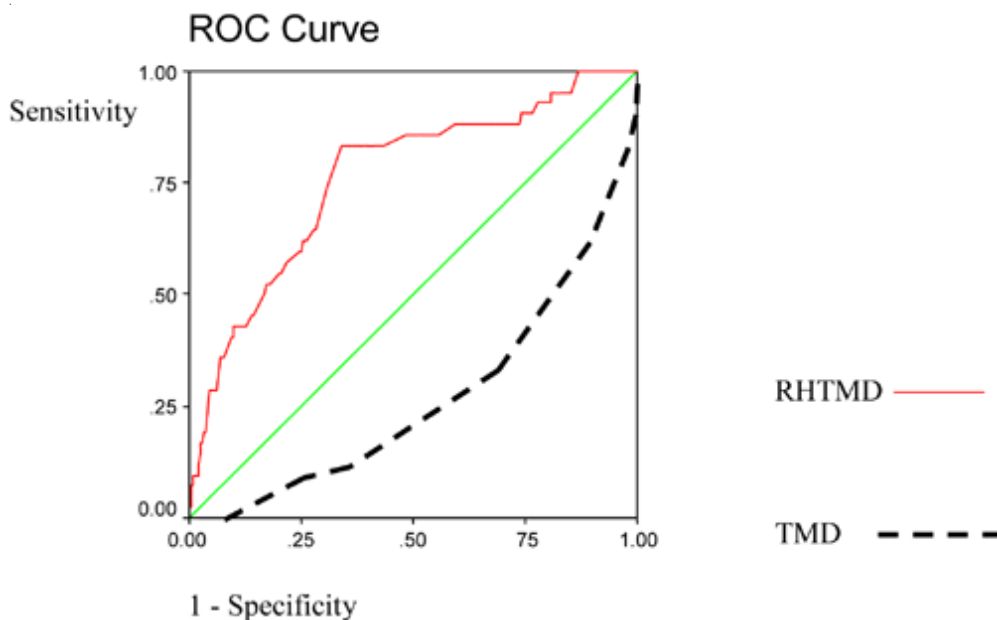
Sex	
Male	173 (49%)
Female	209 (51%)
Age (yrs)	45 $\pm$ 12
Weight (kg)	56 $\pm$ 10
Height (cm)	159 $\pm$ 7
ASA classification	
I	284 (79%)
II	98 (21%)

Value shown as number (%) mean  $\pm$  SD

**Table 2.** Accuracy of risk factors in predicting difficult laryngoscopy (Number)

Risk factors	True Positive	True negative	False Positive	False negative	Sen. (%)	Spec. (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Area under ROC curve (95% CI)
Thyromental distance	28	234	106	14	67	68	20	94	0.27 (0.19-0.36)
Ratio of height to thyromental distance	35	221	119	7	83	65	23	97	0.76* (0.68-0.84)

\* p < 0.05; Area under ROC curve of RHTMD compare to TMD



**Fig. 1** Receiver operating characteristic curve for the ratio of height to thyromental distance (RHTMD) and thyromental distance (TMD) in the prediction of difficult tracheal intubation

graphic data of all patients is presented in Table 1. Difficult intubation (Cormack and Lehane grade 3 or 4) was reported in 42 patients (10.9%). Sensitivity, specificity, positive and negative predictive value and AUC of each risk factor in predicting difficult intubation are shown in Table 2. The relationship between sensitivity and specificity is demonstrated by the ROC curves plotted in Fig. 1. The AUC (95% confidence interval) was 0.27 (0.19-0.36) for TMD and 0.76 (0.68-0.84) for RHTMD. The AUC for RHTMD was significantly greater than the AUC for TMD ( $p = 0.00$ ). The optimal cut-off point for predicting a difficult intubation was 23.5 for RHTMD (sensitivity 83%; specificity 65%) and 6.5 cm for TMD (sensitivity 67%, specificity 68%).

### Discussion

In the present study, the incidence of difficult intubation (10.9%) was higher when compared with previous studies<sup>(3-5)</sup>. Our data demonstrate that the advantage of RHTMD is a similar specificity with improved sensitivity in comparison with TMD. The AUC of RHTMD was significantly greater than AUC of TMD. This indicates that RHTMD had better accuracy in predicting difficult intubation than TMD.

Nevertheless, the authors believe that decreasing false negative prediction is far more important than falsely predicting difficult intubation in unaffected patients. The consequence of a false negative result may be deleterious and an even life-threatening condi-

tion. If difficult intubation is infrequent, the incidence of false negatives is small. Still, the sensitivity of a test should be high enough to detect possible difficult intubation. RHTMD measurement results in less detection failure of difficult intubation than TMD measurement. This is the authors' most important finding, and it supports previous work by Schmitt and Kirmse<sup>(17)</sup>.

Schmitt and Kirmse<sup>(17)</sup> found that RHTMD  $\geq$  25 could be used to predict difficult intubation for Caucasian men and women. In the present study, RHTMD  $\geq$  23.5 was a determining factor in predicting poor laryngeal view for Thai patients. This difference is small, and further investigation is required to determine the significance of ethnicity. The combination of RHTMD with other risk factors for the prediction of difficult airway management also requires further study.

In conclusion, several studies have addressed different variables alone or in combination to determine an ideal method for predicting difficult intubation. The anesthesiologist makes daily airway assessments that are extremely important, and the RHTMD may represent a useful means for achieving a faster, simpler and more accurate prediction of a difficult airway.

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การตรวจประเมินเพื่อทำนายภาวะใส่ท่อหายใจลำบากในคนไทย ด้วยการใช้สัดส่วนของส่วนสูงต่อระยะทางระหว่างกระดูกซี่โครงยอดและคางเปรียบเทียบกับการวัดระยะทางระหว่างกระดูกซี่โครงยอดถึงคาง

บรรจง ครอบบัวบาน, ศิริวรรณ ดิเรกโภาค, สุจริต คำแก้ว

**บทนำ:** การค้นหาความเสี่ยงของผู้ป่วยในการใส่ท่อช่วยหายใจลำบาก ได้จากตรวจประเมินผู้ป่วยก่อนผ่าตัดและให้ยาระงับความรู้สึกเป็นสิ่งสำคัญ แต่ปัจจุบันยังไม่ทราบชัดเจนว่าตัวแปรใดใช้ทำนายได้ถูกต้องและตัวแปรใดที่เหมาะสมที่สุดในการใช้ประเมินผู้ป่วย แม้ว่าการวัดระยะทางระหว่างกระดูกซี่โครงยอดและคาง จะถูกใช้ในการประเมินผู้ป่วยเพื่อทำนายภาวะใส่ท่อช่วยหายใจลำบาก แต่ค่าของ TMD ยังไม่แน่นอน อีกทั้งแปรผันตามขนาดและสัดส่วนของผู้ป่วยด้วย

**วัตถุประสงค์:** เพื่อศึกษาการใช้สัดส่วนของส่วนสูงต่อ TMD เปรียบเทียบ TMD ในการตรวจประเมินเพื่อทำนายภาวะใส่ท่อหายใจลำบากในคนไทย

**วัสดุและวิธีการ:** ผู้ป่วย 382 รายที่เข้ารับการผ่าตัดภายใต้การให้ยาระงับความรู้สึกทั่วไป ร่วมกับการใส่ท่อหายใจ จะได้รับการตรวจประเมินระบบทางเดินหายใจก่อนการให้ยาระงับความรู้สึกตามภาคปฏิบัติปกติ และบันทึกค่า TMD และส่วนสูงโดยวิสัญญีแพทย์คนเดียว ผู้ดมยาสลบเป็นผู้บันทึก laryngoscopic view กำหนดให้ laryngoscopic view เกรด 3 และ 4 เป็นภาวะใส่ท่อหายใจลำบาก ใช้ receiver operating characteristic curve กำหนด cut-off point ของ RHTMD และ TMD และเปรียบเทียบพื้นที่ใต้กราฟ ROC เพื่อดู performance ของแต่ละการทดสอบ นอกจากนี้คำนวณหา sensitivity, specificity และ positive and negative predictive value ตามสูตรมาตรฐาน

**ผลการศึกษา:** พบผู้ป่วยมีภาวะใส่ท่อหายใจลำบาก จำนวน 42 ราย หรือร้อยละ 10.9 RHTMD มี specificity ใกล้เคียงกับ TMD แต่มี specificity มากกว่า TMD และ พื้นที่ใต้กราฟ ROC ของ RHTMD มากกว่า พื้นที่ใต้กราฟ ROC ของ TMD อย่างมีนัยสำคัญทางสถิติ ( $p = 0.00$ )

**สรุป:** การตรวจประเมินเพื่อทำนายภาวะใส่ท่อหายใจลำบากในคนไทย พบว่า การใช้ RHTMD สามารถทำนายภาวะใส่ท่อหายใจลำบากได้ถูกต้องมากกว่าการใช้ TMD ดังนั้นผู้ประเมินผู้ป่วยก่อนให้ยาระงับความรู้สึกอาจจะพิจารณาใช้ RHTMD เป็นวิธีการตรวจประเมินเพื่อทำนายภาวะใส่ท่อหายใจลำบากในการประเมินที่ทำได้เร็ว ง่าย และถูกต้องกว่า

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