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Original Research Article

RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD) AND THE RATIO OF HEIGHT TO STERNOMENTAL DISTANCE (RHSMD) AS PREDICTORS OF DIFFICULT AIRWAY IN ADULT PATIENTS UNDERGOING ENDOTRACHEAL INTUBATION

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Abstract:

Background: Predicting difficult intubation is crucial for anaesthesia practice. This study evaluated the ratio of height to thyromental distance (RHTMD) and the ratio of height to sternomental distance (RHSMD) as predictors of difficult airway in adult patients undergoing endotracheal intubation.

Methods: This prospective observational study included 200 ASA I-II adult patients scheduled for elective surgery under general anaesthesia with endotracheal intubation. RHTMD and RHSMD were measured preoperatively. Cormack-Lehane (C-L) grading was used to assess difficult laryngoscopy. The predictive values of RHTMD and RHSMD were analysed.

Results: The incidence of difficult intubation was 18% (36/200). RHTMD showed higher sensitivity (66.67%) and specificity (98.17%) compared to RHSMD (sensitivity 41.67%, specificity 98.78%). RHTMD demonstrated better positive and negative predictive values than RHSMD.

Conclusion: RHTMD is a more reliable predictor of difficult intubation compared to RHSMD in adult patients undergoing general anaesthesia.

Keywords: Ratio of height to thyromental distance (RHTMD), Ratio of height to sternomental distance (RHSMD), Predictive tests, Endotracheal intubation, Cormack-Lehane grading, Airway assessment.

Introduction:

Anticipating and managing challenging intubation is a crucial skill in the field of anaesthesiology. Difficult or failed intubation stands as a significant contributor to morbidity and mortality related to anaesthesia. Among patients with difficult airways, a substantial majority (85%) face potential hypoxic brain damage. Failed airway management during

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surgery under general anaesthesia contributes significantly to both mortality and morbidity. Incidence rates of such incidents range from 1.5% to 13% in individuals undergoing surgical procedures, leading to unfavourable outcomes in anaesthesia practice [1-4]. Hence, evaluating patients before surgery holds paramount importance in identifying those with difficult airways. Numerous advancements have been made to predict unexpected difficult airways. However, established tests like Patil's Thyromental distance (TMD) measurement, the Mallampatti test and the Wilson scoring system are commonly used. They have shown significant false positive rates in previous studies, diminishing their clinical significance [5-7]. The ratio of Height to Thyromental Distance (RHTMD) is calculated by measuring the distance between the thyroid notch and the tip of the chin, divided by the patient's height. Similarly, the ratio of Height to Sternomental Distance (RHSMD) is determined by dividing the distance between the sternal notch and the tip of the chin by the patient's height. These ratios serve as valuable indicators for predicting ease or difficulty in endotracheal intubation. A lower RHTMD or RHSMD suggests a shorter distance between the respective anatomical landmarks relative to the patient's height, potentially indicating challenges during intubation due to limited space or anatomical variations.

Although very few research studies have compared the HTMD and HSMD ratios, several investigations have explored their utility as predictors for endotracheal intubation. This study aims to evaluate and compare the effectiveness of RHTMD and RHSMD in predicting difficult intubation in adult patients undergoing general anaesthesia.

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Materials and Methods

This observational, cross-sectional study was conducted with institutional ethical approval and written informed consent from participants. A total of 200 ASA grade 1 or 2 patients, aged 18–60 years, undergoing elective surgeries requiring endotracheal intubation under general anesthesia at People's Hospital were included. Study variables included age, sex, weight, height, type of surgery, and Modified Mallampati Grading (MMP).

Inclusion Criteria: Patients aged 18–60 years, ASA grade 1 or 2, scheduled for elective surgeries with endotracheal intubation.

Exclusion Criteria: Lack of consent, obstetric patients, regional anesthesia cases, patients requiring laryngeal mask airways, and those with airway abnormalities, midline neck swelling, limited mouth opening (<3 cm), cardio-respiratory compromise, or unstable cervical spine.

Data were collected using a stadiometer, measuring tape, laryngoscope, and a standardized data sheet. Measurements included MMP (with the patient sitting, mouth open, and tongue protruded), Thyromental Distance (TMD), Sternomental Distance (SMD), Ratio of Height to Thyromental Distance (RHTMD), and Ratio of Height to Sternomental Distance (RHSMD). Predictive thresholds were RHTMD > 23.5, RHSMD > 12.5, MMP grade 3/4, TMD < 6.0 cm, and SMD < 12.5 cm.

Patients were pre-oxygenated and induced with Inj. Propofol (2 mg/kg IV) and Inj. Succinylcholine (2 mg/kg IV). Laryngoscopy, performed by a senior anesthesiologist, assessed vocal cords using the Modified Cormack-Lehane classification, where grades 3/4 indicated difficult laryngoscopy. Intubation was confirmed using end-tidal CO2. Patients requiring external laryngeal pressure were excluded.

Data analysis, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), was conducted using SPSS® version 22.0.

Results:

A total of 200 patients were included in the study. The demographic characteristics of the patients are presented in Table 1.

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Table 1: Demographic data

Characteristic	Value
Age (years)	42.5 ± 13.7
Gender (M/F)	108/92
BMI (kg/m²)	24.3 ± 3.2
ASA (I/II)	122/78

Values are presented as mean ± SD or numbers.

The incidence of difficult intubation (C-L grade 3 or 4) was 18% (36/200).

Table 2 shows the distribution of predictive tests based on Cormack-Lehane grading. Out of 164 patients with easy intubation (C-L grade 1 or 2), RHTMD correctly predicted 161 cases, while RHSMD correctly predicted 162 cases. For the 36 patients with difficult intubation, RHTMD correctly identified 24 cases, while RHSMD identified 15 cases.

Table 2: Distribution of predictive tests based on Cormack-Lehane grading

Test	C-L Easy (%)	C-L Difficult (%)	Total (%)	P-value
RHTMD				
Easy	161 (98.17)	12 (33.33)	173 (86.5)	<0.001
Difficult	3 (1.83)	24 (66.67)	27 (13.5)	
RHSMD				
Easy	162 (98.78)	21 (58.33)	183 (91.5)	<0.001
Difficult	2 (1.22)	15 (41.67)	17 (8.5)	
Total	164 (82)	36 (18)	200 (100)	

C-L: Cormack-Lehane grade

Table 3 presents the analysis of RHTMD and RHSMD. RHTMD showed better predictive value compared to RHSMD ($p<0.001$). Of the 173 patients predicted to have easy intubation

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by RHTMD, 10 were predicted as difficult by RHSMD. Among the 27 patients predicted to have difficult intubation by RHTMD, only 17 were predicted as difficult by RHSMD.

Table 3: Analysis of RHTMD and RHSMD

RHTMD	RHSMD Easy <12.5 (%)	RHSMD Difficult >12.5 (%)	Total (%)	P-value
Easy <23.5	163 (89.07)	10 (58.82)	173 (86.5)	<0.001
Difficult >23.5	20 (10.93)	7 (41.18)	27 (13.5)	
Total	183 (91.5)	17 (8.5)	200 (100)	

RHTMD: Ratio of height to thyromental distance; RHSMD: Ratio of height to sternomental distance

Table 4 compares the sensitivity, specificity, positive and negative predictive values, and accuracy of RHTMD and RHSMD. RHTMD demonstrated higher sensitivity (66.67% vs 41.67%) and better overall accuracy (92.50% vs 88.50%) compared to RHSMD.

Table 4: Comparison of RHTMD and RHSMD

Parameter	RHTMD (95% CI)	RHSMD (95% CI)
Sensitivity	66.67 (49.03-81.44)	41.67 (25.51-59.24)
Specificity	98.17 (94.84-99.63)	98.78 (95.68-99.85)
PPV	88.89 (70.84-97.65)	88.24 (63.56-98.54)
NPV	93.06 (88.21-96.35)	88.52 (82.99-92.69)
Accuracy	92.50 (87.97-95.74)	88.50 (83.21-92.60)

RHTMD: Ratio of height to thyromental distance; RHSMD: Ratio of height to sternomental distance; PPV: Positive predictive value; NPV: Negative predictive value; CI: Confidence interval

Discussion

This study compared the effectiveness of the Ratio of Height to Thyromental Distance (RHTMD) and Ratio of Height to Sternomental Distance (RHSMD) in predicting difficult

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intubation in adults undergoing general anesthesia. The incidence of difficult intubation was 18%, consistent with other studies, such as Bhiwal et al. (17.33%) but slightly higher than Amruthraju et al. (15%) and S et al. (14.5%). Variations may arise from differences in patient demographics, definitions of difficult intubation, or clinician expertise.

RHTMD proved a superior predictor, demonstrating higher sensitivity (66.67% vs. 41.67%) and accuracy (92.50% vs. 88.50%) compared to RHSMD. These results align with Amruthraju et al., who also reported RHTMD's better predictive value ($p = 0.001$). While S et al. found higher sensitivities for both ratios, discrepancies might stem from differing cutoff values (RHTMD > 23.5 vs. < 21.5).

Interestingly, our findings contrast with Prakash et al., who found neither RHTMD nor TMD reliable, instead favoring thyromental height (TMH) as a predictor. These differences underscore the need for further research to identify the most consistent airway assessment tools.

Both RHTMD (98.17%) and RHSMD (98.78%) showed high specificity, minimizing false positives and ensuring efficient airway management. However, the sensitivity of RHTMD (66.67%) indicates it misses approximately one-third of difficult cases, highlighting the need to combine it with other predictive tests. RHTMD's high PPV (88.89%) and NPV (93.06%) further validate its reliability in identifying and ruling out difficult intubation.

The superiority of RHTMD likely reflects its consideration of height relative to thyromental distance, a crucial anatomical determinant. RHSMD, while useful, may be less precise due to variability in sternomental distance measurements.

Strengths of this study include its prospective design, standardized techniques, and assessments by experienced anaesthesiologists. However, limitations such as a single-center setting, relatively small sample size, and lack of consideration for other potential predictors (e.g., neck circumference or dentition) may limit generalizability. Future multi-center studies with broader variables are needed to refine predictive models for difficult intubation.

Conclusion:

This study demonstrates that the ratio of height to thyromental distance (RHTMD) is a more effective predictor of difficult intubation compared to the ratio of height to sternomental distance (RHSMD) in adult patients undergoing general anesthesia. With a higher sensitivity, better overall accuracy, and superior positive and negative predictive values, RHTMD proves to be a valuable tool for preoperative airway assessment. The observed 18% incidence of difficult intubation underscores the ongoing importance of reliable predictive methods. While

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both RHTMD and RHSMD show high specificity, the limitations in sensitivity highlight the need for a multi-faceted approach to airway evaluation. The incorporation of RHTMD into routine preoperative screening, in conjunction with other established methods and clinical judgment, could significantly enhance the identification of patients at risk for difficult intubation. However, further large-scale, multi-center studies are warranted to validate these findings across diverse populations and explore potential combinations with other predictive tests. Ultimately, while RHTMD emerges as a promising tool, anesthesiologists must maintain a high index of suspicion for difficult airways and be prepared with alternative management strategies to ensure optimal patient safety and perioperative outcomes in airway management.

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