ORIGINAL RESEARCH   **AIRWAY MANAGEMENT**

A comparative study between tongue thickness measured by ultrasonography and thyromental distance in anticipation of difficult intubation

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ABSTRACT

Background & objective: Difficult intubation remains a risk for patients undergoing general anesthesia (GA) or mechanical ventilation in an intensive care unit (ICU). Macroglossia is a known factor for difficult intubation. But it is not routine to assess the tongue size to predict difficult intubation. Studies are found deficient in comparing usefulness of measuring thyromental distance and the tongue thickness (TT) measured by ultrasonography to estimate difficult intubation. We compared tongue thickness measured by ultrasonography and thyromental distance as a means to anticipate difficult intubation.

Methodology: **A** convenient sample of 60 patients; 32 males and 28 females, who were undergoing elective surgery with GA were included. Thyro-mental distance (TMD), along with tongue thickness (TT) were measured consecutively in each patient in a transitional room. After induction of GA, Cormack Lehane (CL) score was assessed for all patients to detect difficult intubation.

Results: Thyro-mental distance was significantly reduced in patients with difficult intubation, while the reverse was in the measurement of tongue thickness; where patients with difficult intubation had significantly a greater TT than those with no difficult intubation. TT measurement had significantly higher sensitivity and specificity (38%, and 96% respectively; $P = 0.002$) than thyro-mental distance in the detection of difficult intubation.

Conclusion: In this study we demonstrated that there was statistically significant inverse relationship of thyro-mental distance on CL, and statistically significant direct relationship of tongue thickness on CL. The results showed that tongue thickness was more effective to detect difficult intubation.

Abbreviations: CL - Cormack Lehane; TMD - Thyro-mental distance; TT - Tongue thickness;

Keywords: Tongue Thickness; Thyromental Distance; Difficult Intubation

1. INTRODUCTION

Expertise in airway management is one of the essential skills, with which every healthcare professional must be well-familiar.[1] Maintaining a patent airway is essential for adequate oxygenation and ventilation in critical patients, and failure to do so, even for a brief period of time, can be life threatening.[2,3] Difficult airway remains a risk for patients scheduled for general anesthesia (GA) and a real test for the anesthetists.[1,4] The failure to maintain a patent airway following the induction of GA is a major concern for anesthesiologists; for securing the airway, tracheal intubation using laryngoscopy remains the method of choice in most cases.[1]

The unanticipated difficult laryngoscopic intubation places patients at increased risk of complications ranging from sore throat to serious airway trauma.[5,6] Failure to maintain a patent airway can lead to severe complications such as brain damage or even death.[7] Since these risks may be avoided by securing the airway prior to the induction of GA by alternative methods of tracheal intubation (e.g., fiberoptic bronchoscopy), it would be useful to identify these patients preoperatively. Previous studies put the prevalence of difficult intubation in surgical patients at 1.54% to 15.4%.[6,8]

There are two main types of endotracheal intubation; direct and video laryngoscopy, the first type allows a good visualization by aligning airway axis's (oral-pharyngeal-laryngeal axis) to achieve a line of sight.[3] Difficult intubation is defined when an experienced laryngoscopist, using direct laryngoscopy, requires more than two attempts with the same blade or; a change in the blade or an adjunct to a direct laryngoscope (e.g. bougie) or use of an alternative device or technique following failed intubation with direct laryngoscopy.[8,9] There have been no precise methods to predict airway accurately. Searching for more accurate methods is still important for anesthetists.[3,10] Most tests used to predict difficult intubation, have poor sensitivity and specificity, particularly in the emergency patient when it can be difficult to obtain a comprehensive evaluation. If a particular feature associated with difficult intubation is present, whilst more likely, it does not necessarily mean that the patient will be difficult to intubate. Likewise, if a feature is absent, it does not rule out the possibility of a difficult intubation.[9]

Anesthetists know that increased tongue thickness (macroglossia) affects the performance of laryngoscopy, and therefore can lead to difficult intubation.[10] However, there are no precise and accurate methods to measure tongue thickness. To aid the anesthesiologist in identifying patients whose tracheas are unexpectedly difficult to intubate by direct laryngoscopy, several non-invasive clinical preoperative airway measures have been described that possess significant associations with difficult intubation.[11-15] To develop more predictive models, several investigators have examined the relationship of multiple airway measures and difficult intubation.[8,16–19] These studies have had conflicting results in that the predictability of the resulting models varies widely. Thyromental distance < 6–7 cm, from the top of the thyroid cartilage to the anterior border of the mandible with the neck in full extension implies a short mandible and/or a high larynx; both may impair the view at laryngoscopy or make intubation very difficult.[9] The normal tongue thickness was > 3.5 cm.[3] It has been suggested that the size of the base of the tongue is an important factor determining the degree of difficulty of direct laryngoscopy.

We compared the usefulness of measuring thyromental distance and tongue thickness measured by ultrasonography in estimation of difficult intubation; and to develop a clinically useful and valid model for predicting difficult laryngoscopic tracheal intubation in patients seemingly with normal airways.

2. METHODOLOGY

This is a comparative observational study that compared between the effectiveness of TT, and TMD to detect difficult intubation, which was conducted at the surgical ward of Baghdad Teaching Hospital from 15 January, 2024 to 1st March, 2024. Verbal consents were obtained from the patients before enrolment in the study.

A convenient sample of 60 patients, who were subjected to both TMD measured in centimeters, as well as TT measured by ultrasonography, respectively, and comparison was done between the TT and TMD measurements in relation to difficult intubation. The following inclusion criteria were used: 18-60 y old patients of both sexes, ASA physical status I and II, body mass index below 35kg/m^2, scheduled to undergo GA requiring tracheal intubation. Patients with upper airway anatomical deformity, trauma, or tumor, that subglottic airway stenosis, patients scheduled for modified anesthesia protocol rather than GA such as neuraxial anesthesia or previous history of cancellation of tracheal intubation for known difficult airway, were excluded.

2.1. Airway assessment

All enrolled patients underwent an ultrasonographic measurement of tongue thickness in a transitional room before transport to the operating room. A high-frequency linear probe (SonoSite, USA) was used for the ultrasonography. The sonographic measurements were performed by the researcher himself.

The patient was supine in sniffing position. All of the patients were asked to hold their mouth closed and to place the tongue tip slightly touching the incisors, and no phonation. The probe was placed under the chin in the median sagittal plane and adjusted to obtain the entire tongue outline clearly on the screen. This image was frozen. The maximal vertical dimension from the tongue surface to the submental skin was measured and defined as the tongue thickness.

Thyromental distance was measured in centimeters when patient was in supine position, neutral and extending his or her neck by measuring tape from the upper border of thyroid cartilage to the anterior border of the mandible.

The two measurements were taken on the day of surgery.

Table 1: Demographic characteristics of the study sample

Variables		Result
Age (y)		36.6 ± 13.00
Gender	Male	32 (53.3)
	Female	28 (46.7)
Data presented as mean ± SD or n (%)		

2.2. Classification of laryngoscopic view

Airway evaluations were completed, and the patients were transferred to the theatre. The patients were placed in a supine position. GA was induced and muscle relaxant was used. A Macintosh number 3 or number 4 laryngoscope blade was used.

The laryngoscopic view was assessed and classified according to Cormack and Lehane: Grade1 and 2 indicate non difficult intubation, while Grade 3 and 4 refer to difficult intubation.

2.3. Statistical analysis

The collected data was handled and analyzed by IBM© SPSS (Statistical Package for the Social Sciences) Statistics Version 24. All analyses were done with 95% confidence intervals (CI) and P-values less than 0.05 were considered statistically significant throughout this study. The data was presented as mean and standard deviation, or frequencies and percentages for the categorical variables. The t-test and chi-square test were used to analyze the associations for numerical and categorical data respectively.

3. RESULTS

A total of 60 patients were subjected to TMD, and then to TT measurements. The sample contained approximately equal percentage of both genders, 53.3%, and 46.7% for males and females respectively, with mean age 36.6 ± 13.00 y, as illustrated by Table 1.

TMD was significantly reduced in patients with difficult intubation, while the reverse was in the measurement of TT; where patients with difficult intubation had significantly a greater TT than those with no difficult intubation (Table 2).

A non-significant association was found between the age difficult intubation (Table 3).

Table 4 shows that TT (tongue thickness) measurement had significantly higher sensitivity and specificity than TMD (thyro-mental distance) in the detection of difficult intubation.
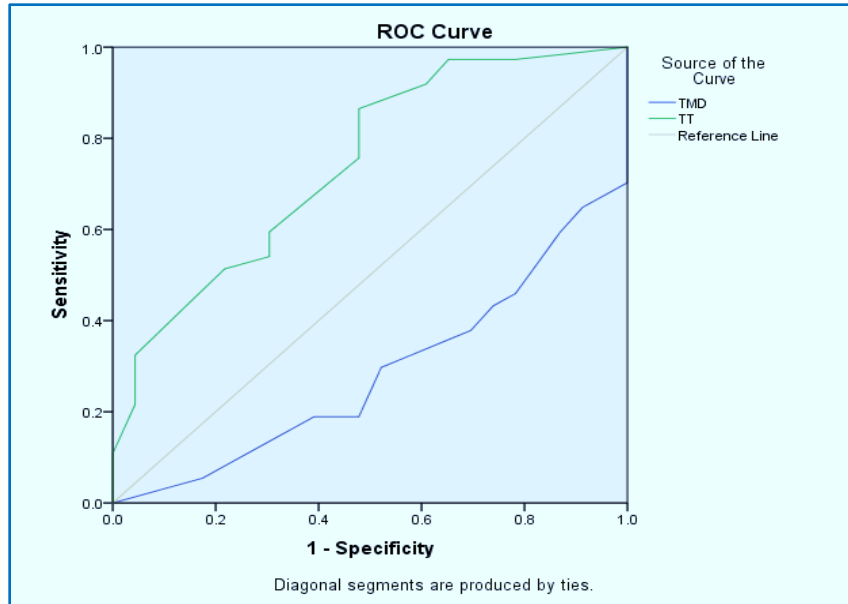
4. DISCUSSION

Several non-invasive clinical preoperative airway assessment techniques have been described to help anesthetists in identification of patients who are difficult to intubate. A significant association of clinical predictors of airway assessment with difficult intubation is seen according to Tasli H.[11] Frequency of difficult intubation among adults has been reported as 1% - 18% according to other studies.[13,14]

This study illustrated that patients who had difficult intubation; were having significant lower TMD, and TT (P = 0.002, P = 0.001 respectively) than those who had no difficulty in tracheal intubation.

It was confirmed by this study that TT measured by US; was more

Table 2: Effect of TMD, and TT measurements on difficult intubation

Measurements	Difficult intubation		P -value
	Yes (CL3,4) *	No (CL1,2)	
TMD (cm)	5.61 ± 2.08	7.12 ± 1.39	0.002
TT (cm)	4.20 ± 0.77	3.45 ± 0.82	0.001
CL= Comack-Lehane; Data presented as mean ± SD			

Table 3: Association between age and difficult intubation

Variables	Difficult intubation		p-value
	Yes (CL 3, 4)	No (CL 1, 2)	
Age (y)	36.76 ± 14.00	36.35 ± 11.50	0.68
Data presented as mean ± SD			

Table 4: Diagnostic characteristics of TMD & TT in detection of difficult intubation

Variables	Sensitivity	Specificity	UAC	Cut-off value (cm)	P-value
TMD	15%	83%	0.286	8.15	0.006
TT	38%	96%	0.742	4.7	0.002

Figure 1: ROC Curve expressing the diagnostic characteristics of TMD and TT to detect difficult intubation

effective in anticipation of CL grade 3 and 4 difficult intubations. There was significant inverse correlation (r = -0.870) of the TMD and anticipation of difficult intubation (represented by CL), which was also supported by a previous study.[15] Our study demonstrates that tongue thickness, as measured accurately using ultrasonography, is a useful predictor for predicting difficult airway. Multivariable logistic regression demonstrates that tongue thickness may be an independent predictor of both difficult laryngoscopy and difficult tracheal intubation.[3]

Meenal M. et al. show that the measurement of thyromental distance as a predictor of difficult intubation as with the atlanto-occipital joint maximally extended, the distance between the tip of the mentum and the prominence of the thyroid cartilage is 6.0-6.5 cm, intubation will be difficult; if less than 6 cm, extremely difficult or impossible.[13] Which supports our study, it means that decreased TMD will lead to difficult intubation (CL 3 and 4).

Intubation was more difficult in the obese patients, whereas the incidence of difficult laryngoscopy (i.e., Cormack class III or IV) was similar in obese and lean patients. This is not surprising, because factors complicating laryngoscopy do not reflect the full spectrum of complex events that can make intubation difficult or easy.[13-19]

5. LIMITATIONS

This was a single center study relied on 60 patients only, which may affect the generalization of the results for the general population.

5. CONCLUSION

In this study we demonstrated that tongue thickness was more effective than thyro-mental distance in anticipation. there was statistically significant inverse relationship of thyro-mental distance to Cornack-Lehane grade 3 and 4, and statistically significant direct relationship of TT to Cornack-Lehane grade 3 and 4 (difficult intubation).

6. RECOMMENDATIONS

- We recommended the measurement of tongue size by US and TMD preoperatively to detect difficult intubation to prevent further complications.
- To follow strategies to lower body weight to decrease chance of difficult intubation as increase BMI will lead to difficult intubation.
- Enhance facilities to manage difficult intubation like: video laryngoscope, fibro optic laryngoscope.
- Further clinical studies are needed about risk or precipitating factors that can lead to difficult intubation.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

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9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

ABK: Study design, data collection, final article writing.

GRH: Statistical data analysis and writing of the final article

7. REFERENCES

1. Aktas S, Atalay YO, Tugrul M. Predictive value of bedside tests for difficult intubations. Eur Rev Med Pharmacol Sci. 2015;19(9):1595-9. [PubMed]

2. Wojtczak JA. Submandibular sonography: assessment of hyomental distances and ratio, tongue size, and floor of the mouth musculature using portable sonography. J Ultrasound Med. 2012;31(4):523-8. [PubMed] DOI: 10.7863/jum.2012.31.4.523

3. Yao W, Wang B. Can tongue thickness measured by ultrasonography predict difficult tracheal intubation? Br J Anaesth. 2017;118(4):601-9. [PubMed] DOI: 10.1093/bja/aex051

4. Duke J. Anesthesia secrets. Elsevier Health Sciences; 2011.

5. Hirsch IA, Reagan JO, Sullivan N. Complications of direct laryngoscopy. A prospective analysis. Anesthesiology Review 1990; 17: 34–40. [PubMed]

6. Johnson KH, Hood DD. Esophageal perforation associated with endotracheal intubation. J Am Soc Anesthesiol. 1986;64(2):281-2. DOI: 10.1097/00000542-198602000-00031

7. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: a closed claims analysis. Anesthesiology. 1990;72:828–33. DOI: 10.1097/00000542-199005000-00010

8. Voyagis GS, Kyriakis KP, Dimitriou V, Vrettou I. Value of oropharyngeal Mallampati classification in predicting difficult laryngoscopy among obese patients. Eur J Anaesthesiol. 1998;15(3):330-4. [PubMed] DOI: 10.1046/j.1365-2346.1998.00301.x

9. Gupta B, Bhardwaj BB, Agrawal N. Airway Management in Emergency Department. In: The Airway Manual: Practical Approach to Airway Management. Singapore: Springer Nature Singapore; 2023. p. 645-660. DOI: 10.1007/978-981-19-4747-6_37

10. Ibrahim MN. ASA Difficult Airway Algorithm: Adult Patients. In: Anesthesia Oral Board Review: Knocking Out The Boards. Cambridge University Press; 2023.

11. Tasli H, Karaman NE, Isler D, Subasi B. A predictor of difficult airway: the tasli classification in transnasal flexible laryngoscopy. J Voice. 2023;37(6):945-50. [PubMed] DOI: 10.1016/j.jvoice.2021.06.022

12. Regnard C, Dean M. A guide to symptom relief in palliative care. CRC Press; 2022 Jan 26. DOI: 10.1201/9780429083921[PubMed]

13. Meenal M, Samal RL, Nanda K, Ali SM. Assessment of Correlation Between Mentohyoid Distance and Cormack-LehaneGrading in Airway Assessment: A Predictor of Tracheal Intubation. Eur J Mol Clin Med. 2022;9(3):5748-55. [FreeFullText]

14. Ellard L, Wong DT. Preoperative airway evaluation. Curr Anesthesiol Rep. 2020;10:19-27.

15. Khomane AB, Chhallani V, Raddi P. A prospective observational study to predict difficult endotracheal intubation using non-invasive tests. Int J Life Sci Biotechnol Pharma Res. 2023 Jul-Sep;12(3). [FreeFullText]

16. Çelik G, Zengin S, Ergün MO, Umuroğlu T. Correlation between neck circumference measurement and obesity type with difficult intubation in obese patients undergoing elective surgery. J Surg Med. 2021;5(9):912-6. DOI: 10.28982/josam.989262

17. Michalek P, Magboul MM, Toker K, Donaldson W, Ozaki M. Advances and Controversies in Perioperative Airway Management. Biomed Res Int. 2016;2016:1965623. [PubMed] DOI: 10.1155/2016/1965623

18. Srinivasan C, Kuppuswamy B. Comparison of validity of airway assessment tests for predicting difficult intubation. Indian Anaesthetists Forum. 2017 Jul 1;18(2):63-68. DOI: 10.4103/TheIAForum.TheIAForum_31_17

19. Thota B, Jan KM, Oh MW, Moon TS. Airway management in patients with obesity. Saudi J Anaesth. 2022;16(1):76-81. [PubMed] DOI: 10.4103/sja.sja_351_21