

# Predictors of difficult intubation – a simple approach

A Vasudevan, A Badhe

## Citation

A Vasudevan, A Badhe. *Predictors of difficult intubation – a simple approach*. The Internet Journal of Anesthesiology. 2008 Volume 20 Number 2.

## Abstract

**Background:** A common cause of anaesthesia related morbidity and mortality is difficult or failed intubation. A lot of studies have attempted to create a score or mathematical model to predict difficult intubation accurately without much success. Many of them consider all predictive parameters as equal. This study attempts to rank the predictors of difficult intubation without creating complicated mathematical models. **Methods:** Modified mallampati class, degree of head extension, mento-hyoid distance, thyromental distance, interincisor gap, forward movement of the mandible and indirect laryngoscopy were assessed in 498 patients scheduled for elective surgery. Grading of glottis exposure on direct laryngoscopy was done based on Cormack-Lehane classification. Logistic regression analysis was done to identify factors that were significantly associated with difficult glottis exposure (Grades 3 & 4). The predictors were ranked according to the 'odds' derived from regression analysis. **Results:** Direct laryngoscopy was difficult in 40 patients (8%). Indirect laryngoscopy was excluded from the analysis in view of poor patient cooperation in a large number of patients (13%). Degree of head extension, Mento-hyoid distance of < 4 cm and modified Mallampati class 3&4 were found to have significant association with difficult glottic exposure. These predictors could be ranked in the same order based on 'odds' ratio (11, 3.4, and 2.5 respectively) calculated from logistic regression analysis. **Conclusion:** Patients with restricted head movement have much higher 'odds' of having a difficult glottic exposure at direct laryngoscopy, followed by those with decreased mentohyoid distance and higher modified mallampati class.

## BACKGROUND

A common cause of anaesthesia related morbidity and mortality is difficult or failed intubation. Difficulty in intubation is usually associated with difficulty in exposing the glottis by direct laryngoscopy. This involves a series of maneuvers like extending the head, opening the mouth, displacing and compressing the tongue into the submandibular space and lifting the mandible forward. The ease or difficulty in performing each of these maneuvers can be assessed by one or more parameters.

Extension of head at the atlanto-occipital joint can be assessed by simply looking at the movements of the head, measurement of sternomental distance or by using devices to measure the angle<sub>1</sub>. Mouth opening can be assessed by measuring the distance between upper and lower incisors with the mouth fully open. The ease of lifting the mandible can be assessed by comparing the relative position of the lower incisors in comparison with the upper incisors after forward protrusion of the mandible<sub>2</sub>. The measurement of mento-hyoid distance and thyromental distance provide a rough estimate of the submandibular space<sub>3,4,5,6</sub>. The ability of the patient to move the lower incisor in front of the upper incisor tell us about jaw movement. The classification

provided by Mallampati et al<sub>7</sub>, and later modified by Samsoun and Young<sub>8</sub> help to assess the size of tongue relative to oropharynx. Indirect laryngoscopy can be used to assess the concealment of the larynx by the base of the tongue<sub>9</sub>. It also helps in visualizing the structures above the glottis. Abnormalities in one or more of these parameters may help predict difficulty in direct laryngoscopy<sub>10</sub>.

Initial studies tried to compare individual parameters to predict difficult intubation with mixed results<sub>7,8,11</sub>. Later studies have attempted to create a scoring system<sub>12,13</sub> or a complex mathematical model<sub>14,15</sub>. This study is an attempt to verify which of these factors are significantly associated with difficult exposure of glottis and to rank them according to the strength of association.

## METHODS

The study was conducted after obtaining institutional review board approval. Four hundred and ninety eight, ASA I adult patients, scheduled for various elective procedures under general anesthesia, were included in the study after obtaining informed consent. Patients with gross abnormalities of the airway were excluded from the study.

All patients were assessed the evening before surgery by a single observer. The details of airway assessment are given in Table 1.

**Figure 1**

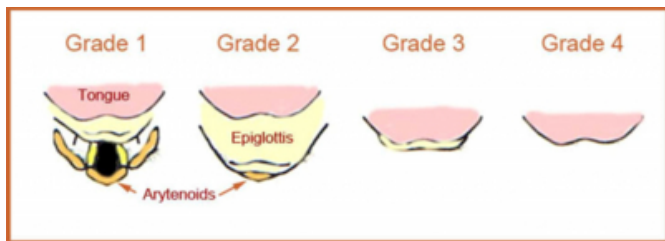
Table 1: Method of assessment of various airway parameters (predictors)

Airway parameter	Method of assessment
1. Modified Mallampati Classification	Class 1: Uvula, faucial pillars and pharyngeal wall seen Class 2: Soft palate & base of the uvula seen  Class 3: Only soft palate seen Class 4: Soft palate not seen
2. Indirect Laryngoscopy	Grade 1: Most of glottis seen Grade 2: Posterior commissure seen Grade 3: Only epiglottis seen Grade 4: Not even epiglottis seen
3. Degree of head extension	Grade 1: Adequate ( $\geq 90^\circ$ ) Grade 2: Mild restriction ( $= 90^\circ$ ) Grade 3: Moderate to severe restriction ( $< 90^\circ$ )
4. Jaw protrusion (SLUX)	Grade 1: Lower incisors beyond the upper incisors Grade 2: Lower incisors at the level of upper incisors Grade 3: Lower incisors behind the upper incisors
5. Inter-incisor gap	Distance between upper and lower incisors (cms)
6. Mento-hyoid distance	Distance between body of hyoid and tip of chin in the midline, with head fully extended (cms)
7. Thyromental distance	Distance between tip of thyroid cartilage and tip of chin, with head fully extended (cms)

Direct laryngoscopy with Macintosh blade was done by an anesthetist who was blinded to preoperative assessment. Glottic exposure was graded as per Cormack-Lehane classification<sub>16</sub>(Fig 1):

**Figure 2**

Figure 1: Cormack-lehane grading of glottic exposure on direct laryngoscopy



- GRADE 1: Most of the glottis visible
- GRADE 2: Only the posterior extremity of the glottis and the epiglottis visible
- GRADE 3: No part of the glottis visible, only the epiglottis seen
- GRADE 4: Not even the epiglottis seen

Grades 1 and 2 were considered as ‘easy’ and grades 3 and 4 as ‘difficult’.

**RESULTS**

Glottic exposure on direct laryngoscopy was difficult in 40 (8%) patients. The frequency of patients in various categories of ‘predictor’ variables is given in Table-2

**Figure 3**

Table 2: The frequency analysis of predictor parameters

Airway parameter	Group	Frequency
Modified Mallampati Classification	Class 1&2	430 (86.4%)
	Class 3&4	68 (13.6%)
Indirect Laryngoscopy	Grade 1&2	376 (75.5%)
	Grade 3&4	56 (11.2%)
	Uncooperative	66 (13.3%)
Degree of head extension	Grade 1	443 (89%)
	Grade 2&3	55 (11%)
Jaw protrusion (SLUX)	Grade 1	444 (89.1%)
	Grade 2&3	54 (10.9%)
Inter-incisor gap	> 3cms	477 (95.8%)
	$\leq 3$ cms	21 (4.2%)
Mento-hyoid distance	> 4 cms	385 (77.3%)
	$\leq 4$ cms	113 (22.7%)
Thyromental distance	> 6 cms	452 (90.8%)
	$\leq 6$ cms	46 (9.2%)

Indirect laryngoscopic assessment could not be done in 66 (13.3%) patients due to excessive ‘gag reflex’. This parameter was excluded from analysis.

Statistical analysis was done with SPSS software version 17.0. In view of the dichotomous nature of the ‘dependent’ variable and multiple ‘predictor’ or ‘independent’ variables, ‘binary logistic regression’ was employed to analyze the significance and strength of association between the predictors and outcome. All the ‘independent’ variables are entered into the equation in the beginning and they were eliminated one by one at each step. When elimination of any variable produced any significant change to the model ( $p < 0.5$ ) it was retained in the equation.

The predictors having significant association to the outcome are:

- Degree of head extension (grades 2&3)
- Mento-hyoid distance (less than 4 cm)
- Modified Mallampati class (grades 3&4)

The strength of association was calculated by ‘odds’ which is an exponential of the correlation coefficient in the equation. The ‘odds’ of having a difficult glottis exposure was highest with ‘degree of head extension’ (odds 11.1) followed by ‘mentohyoid distance’ (odds 3.4) and ‘modified

mallampati class' (odds 2.5)

**Figure 4**

Table 3: Ranking the predictors based on odds ratio

Predictor variable	Odds ratio
1. Degree of head extension (Grades 3 and 4)	11.1
2. Mentohyoid distance (<4 cm)	3.4
3. Modified Mallampati class (Grades 3 and 4)	2.5

**DISCUSSION**

Direct laryngoscopy is the gold standard for tracheal intubation. There is no single definition of difficult intubation. Difficult glottic view on direct laryngoscopy is the most common cause of difficult intubation. The incidence of difficult intubation in this study is similar to that of others.

As for as the predictors are concerned there are wide variations. Restriction of head and neck movement and decreased mandibular space have been identified as important predictors in other studies as well<sup>17</sup>. Mallampati classification has been reported to be a good predictor by many but found to be of limited value by others<sup>17,18,19,20,21,22</sup>. Interincisor gap, forward movement of jaw and thyromental distance produce variable results in previous studies<sup>4,23,24</sup>. Even though thyromental distance is a measure of mandibular space, it is influenced by degree of head extension. Indirect laryngoscopy was mentioned as a predictor of difficult intubation in an earlier report<sup>9</sup>, but the practical applicability is limited in view of high incidence of 'gag' response.

There have been attempts to create various scores in the past. Many of them could not be reproduced by others or of limited practical value<sup>25,26</sup>. Complicated mathematical models based on clinical and/or radiological parameters have been proposed by few in the past<sup>27,28,29</sup>. But these are difficult to understand and tough to follow in clinical setting. Many of these studies consider all the parameters of equal importance.

Instead of trying to find 'ideal' predictor(s), score or model, we simply arrange them in an order based on the strength of association with difficult intubation. Restricted extension of head, decreased mento-hyoid distance and poor Mallampati class are significantly associated with difficult intubation. The 'odds' of a patients with restricted head extension is 11 times compared to those with normal head extension. Similarly patients with decreased mento-hyoid distance and poor Mallampati class have 'odds' of 3.4 and 2.5

respectively compared to those with normal value or grades in the respective categories. In other words patients with decreased head extension have much higher probability of having a difficult intubation compared to those with abnormality in other parameters. The type of equipments needed to manage can be chosen according to the parameter which is abnormal. For example in a patient with decreased mandibular space, it may be prudent to choose devices which do not involve displacement of the tongue like Bullard laryngoscope or Fibre-optic laryngoscope. Similarly in patients with decreased head extension devices like McCoy Larnoscope are likely to be more successful.

**CONCLUSION**

There is no perfect predictor of difficult intubation. Certain abnormalities have much higher probabilities of having a difficult airway compared to others. Restriction of head extension, decreased mento-hyoid distance (mandibular space) and poor Mallampati oropharyngeal class have significant association with difficult glottis exposure in the same order mentioned.

**CORRESPONDENCE TO**

Dr Vasudevan A, No-2, Type-IV, JIPMER campus, Dhanvantri nagar, Puducherry, India- 605006. Email: [jjpmervasu@gmail.com](mailto:jjpmervasu@gmail.com)

**References**

1. Tse JC, Rimm EB, Hussain A. Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia: a prospective blind study. *Anesth Analg* 1995;81(2):254-8.
2. Savva D. Prediction of difficult tracheal intubation. *Br J Anaesth* 1994;73(2):149-53.
3. Chou HC, Wu TL. Mandibulohyoid distance in difficult laryngoscopy. *Br J Anaesth* 1993;71(3):335-9.
4. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy: an assessment of the thyromental distance and Mallampati predictive tests. *Anaesth Intensive Care* 1992;20(2):139-42.
5. Lewis M, Keramati S, Benumof JL, Berry CC. What is the best way to determine oropharyngeal classification and mandibular space length to predict difficult laryngoscopy? *Anesthesiology* 1994;81(1):69-75.
6. Huh J, Shin HY, Kim SH, Yoon TK, Kim DK. Diagnostic predictor of difficult laryngoscopy: the hyomental distance ratio. *Anesth Analg* 2009;108(2):544-8.
7. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiburger D, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. *Can Anaesth Soc J* 1985;32(4):429-34.
8. Samssoon GL, Young JR. Difficult tracheal intubation: a retrospective study. *Anaesthesia* 1987;42(5):487-90.
9. Yamamoto K, Tsubokawa T, Shibata K, Ohmura S, Nitta S, Kobayashi T. Predicting difficult intubation with indirect laryngoscopy. *Anesthesiology* 1997;86(2):316-21.
10. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. *Can J Anaesth* 1994;41(5 Pt

1):372-83.

11. Yeo SW, Chong JL, Thomas E. Difficult intubation: a prospective study. *Singapore Med J* 1992;33(4):362-4.

12. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. *Br J Anaesth* 1988;61(2):211-6.

13. Nath G, Sekar M. Predicting difficult intubation--a comprehensive scoring system. *Anaesth Intensive Care* 1997;25(5):482-6.

14. Charters P. Analysis of mathematical model for osseous factors in difficult intubation. *Can J Anaesth* 1994;41(7):594-602.

15. Arne J, Descoins P, Fuscuardi J, Ingrand P, Ferrier B, Boudigues D, et al. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical multivariate risk index. *Br J Anaesth* 1998;80(2):140-6.

16. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984;39(11):1105-11.

17. Voyagis GS, Kyriakis KP, Roussaki-Danou K, Bastounis EA. Evaluating the difficult airway. An epidemiological study. *Minerva Anesthesiol* 1995;61(12):483-9.

18. Wilson ME, John R. Problems with the Mallampati sign. *Anaesthesia* 1990;45(6):486-7.

19. Restelli L, Moretti MP, Todaro C, Banfi L. [The Mallampati's scale: a study of reliability in clinical practice]. *Minerva Anesthesiol* 1993;59(5):261-5.

20. Laplace E, Benefice S, Marti Flich J, Patrigeon RG, Combourieu E. [Difficult intubation: a prospective evaluation of the Mallampati and Wilson tests]. *Cah Anesthesiol* 1995;43(2):205-8.

21. Oates JD, Macleod AD, Oates PD, Pearsall FJ, Howie JC, Murray GD. Comparison of two methods for predicting difficult intubation. *Br J Anaesth* 1991;66(3):305-9.

22. Lee A, Fan LT, Gin T, Karmakar MK, Ngan Kee WD. A systematic review (meta-analysis) of the accuracy of the Mallampati tests to predict the difficult airway. *Anesth Analg* 2006;102(6):1867-78.

23. Frerk CM. Predicting difficult intubation. *Anaesthesia* 1991;46(12):1005-8.

24. Bilgin H, Ozyurt G. Screening tests for predicting difficult intubation. A clinical assessment in Turkish patients. *Anaesth Intensive Care* 1998;26(4):382-6.

25. Charters P. What future is there for predicting difficult intubation? *Br J Anaesth* 1996;77(3):309-11.

26. Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. *Anesthesiology* 2005;103(2):429-37.

27. Naguib M, Malabarey T, AlSatli RA, Al Damegh S, Samarkandi AH. Predictive models for difficult laryngoscopy and intubation. A clinical, radiologic and three-dimensional computer imaging study. *Can J Anaesth* 1999;46(8):748-59.

28. Karkouti K, Rose DK, Wigglesworth D, Cohen MM. Predicting difficult intubation: a multivariable analysis. *Can J Anaesth* 2000;47(8):730-9.

29. Naguib M, Scamman FL, O'Sullivan C, Aker J, Ross AF, Kosmach S, et al. Predictive performance of three multivariate difficult tracheal intubation models: a double-blind, case-controlled study. *Anesth Analg* 2006;102(3):818-24.

**Author Information**

**Arumugam Vasudevan, M.D.**

Assistant professor, Dept of Anaesthesiology and critical care, Jawaharlal Institute of Postgraduate medical Education and Research (JIPMER)

**Ashok S. Badhe, MD**

Professor and head, Dept of Anaesthesiology and critical care, Jawaharlal Institute of Postgraduate medical Education and Research (JIPMER)