



Correlation between Ultrasound Measured Distance from Skin to Epiglottis and Epiglottis to Mid-Vocal Cord with Cormack-Lehane Classification for Predicting Difficult Intubation

Sussan Soltani Mohammadi*, Abdolhossein Baradaran Tavakkoli, Mojtaba Marashi

Department of Anesthesiology and Critical Care and Pain Medicine, Dr Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran.

ARTICLE INFO

Article history:

Received 28 July 2019

Revised 19 August 2019

Accepted 01 September 2019

Keywords:

Airway;

Cormack-Lehane grade;

Direct laryngoscopy;

Endotracheal intubation;

Ultrasonography;

ABSTRACT

Background: Difficult tracheal intubation is an important challenge for anesthesiologists. Many anatomical parameters are available for evaluating the ease of tracheal intubation. Cormack-Lehane (CL) grade is one that can reliably predict a difficult intubation but it is an invasive procedure and can be performed in an anesthetised patient so it is not useful during pre-anesthetic airway evaluation. Prediction of the CL grading before operation can help in better airway management during induction of anesthesia.

The aim of this study was to find a correlation between ultrasound measured distance from skin to epiglottis and from epiglottis to mid-vocal cord with Cormack-Lehane grading in patients undergoing general anesthesia for predicting difficult intubation.

Methods: In a cross-sectional study, 60 ASA class I - III patients aged 18 - 70 years who were scheduled for tracheal intubation under general anesthesia were included. Before anesthesia, an ultrasound view of the airway was obtained and the distance from skin to the epiglottis and from the epiglottis to the mid-point between the ends of vocal cords were all recorded. The ultrasound measurements were then compared with the CL grade during direct laryngoscopy under general anesthesia.

Results: Thirty-six patients had CL grade I, twenty-one had CL grade II and three had CL grade III. It was observed that the correlation between CL grade and distance from skin to epiglottis (DSE) with cutoff value 21mm (with an accuracy of 99%, a sensitivity of 100%, and a specificity of 82% ; $P=0.0001$) and from epiglottis to mid vocal cord distance (EMVD) with cutoff value 13.38 (with an accuracy of 99%, a sensitivity of 100%, and a specificity of 85% ; $P=0.01$) and the ratio of DSE/EMVD with cutoff value 1.64 (with an accuracy of 95%, a sensitivity of 100%, and a specificity of 91% ; $P=0.004$) was significant for predicting of difficult intubation in patients with $BMI>25$.

Conclusion: Our study revealed good correlation between DES/EMVC ratio and Cormack-Lehane grade, therefore sonographic measurement criteria may be helpful in airway evaluations before anesthesia for predicting difficult intubation.

© 2020 Tehran University of Medical Sciences. All rights reserved.

Inadequate airway management is one of the major contributors for patient mortality and morbidity during anesthesia so any clinical tool that can improve airway management must be considered as an adjunct to the conventional clinical assessment [1].

Many clinical criteria have been introduced with regard to evaluation of the patient's airway before induction of

anesthesia, including mouth-opening size, Mallampati classification, jaw protrusion, neck extension, thyromental distance and the upper-lip bite test. Cormack-Lehane (CL) grade is one that can reliably predict a difficult intubation but it is an invasive procedure and can be performed in an anesthetised patient so it is not useful during pre-anesthetic airway

The authors declare no conflicts of interest.

* Corresponding author.

E-mail address: soltanmo@sina.tums.ac.ir

© 2020 Tehran University of Medical Sciences. All rights reserved.

evaluation. Prediction of the CL grading before operation can help in better airway management during induction of anesthesia [2-3].

In the last few years, there have been some studies that described various roles of US imaging in airway management. It helps in rapid assessment of the airway anatomy [4-7] In a study by Pinto et al. on 74 adult patients requiring endotracheal intubation there was a relationship between difficult laryngoscopy and US-measured distance from skin to epiglottis(DSE) and they found that increasing DSE is strongly associated with difficult laryngoscopy ($P=0.001$) [8].

In another study by Gupta et al. on 72 patients scheduled for tracheal intubation under general anesthesia, the following measurements were obtained on preoperative airway sonography: (a) the distance from the epiglottis to the midpoint of the distance between the vocal Folds (E-VC), (b) the depth of the pre-epiglottic space (PE), These data were compared with the Cormack-Lehane classification obtained during direct laryngoscopy in the operating room. They found that Cormack-Lehane (CL) grade can be adequately (with 67% -68% sensitivity) predicted by the ratio of PE and E-VC distances ($PE/E-VC$) { $0 < [PE/E-VC] < 1$ CL grade 1; $1 < [PE/E-VC] < 2$ CL grade 2; and $2 < [PE/E-VC] < 3$ CL grade 3} [9].

Although many studies found successful correlation between ultrasound measurements and anatomical landmarks, some studies did not. In a study by Soltani Mohammadi et al, they found weak correlation between Cormack-Lehane grade and PE/E-VC, with 87% sensitivity and 30% specificity [10].

In this regard we conducted a study to find any correlation between ultrasound measured distance from skin to epiglottis and epiglottis to mid-vocal Cord distance with Cormack-Lehane classification for predicting difficult intubation.

Methods

This cross-sectional study was performed in 2017 at Dr. Shariati Hospital of Tehran University of Medical Sciences. The study included 60 ASA class I–III patients aged 18- 70 years, who were scheduled for elective surgery under general anesthesia with direct laryngoscopy and endotracheal intubation. The exclusion criteria were any anatomical disturbances such as facial/cervical fractures, maxillofacial abnormalities, cervical tumors or goiter, patients with tracheostomy tubes, morbid obesity, a mouth opening of <4 cm, hyperextension of neck less than 30 degree and pregnant patients. Data were collected after receiving approval from the Ethical Committee of the Hospital and informed written consent of all patients. Pre-anesthetic sonographic evaluation of the airway was started to obtain the US-measured DSE at the thyrohyoid membrane level, patients were placed supine with their

head and neck in a neutral position without a pillow. Distance from skin to epiglottis was computed at the central axis and was always performed by an anesthesiology resident under the supervision of the attending anesthesiologist, using a high-frequency linear probe (Medison L5-12EC), (Figure1).

Figure 1- Ultrasound-measured DSE. Distance from skin to epiglottis is computed as the value of measurement taken at the central axis.



For next measurement after active maximal head-tilt and chin-lift the probe was placed in the midline aspect of the submandibular region. The position of the probe was kept unchanged, only rotating from cephalad to caudal (plane G, an oblique transverse plane bisecting the epiglottis and posterior-most part of the vocal folds with arytenoids) in a single two-dimensional view. Further rotation of the ultrasound probe was stopped upon visualization of plane G (Figure 2).

Figure 2- Ultrasonic plane G for airway evaluation



Plane G was used for sonographic measurements the distance from the epiglottis to the midpoint distance between the vocal folds, (Figure3).

Figure 3- Sonographic measurement the distance from the epiglottis to the midpoint between the vocal cords



For documentation of Cormack-Lehane grade the anesthesiologist was asked to view the vocal-cord by direct laryngoscopy performed before intubation as follows:

Grade I: Visualization of the entire laryngeal aperture.

Grade II: Visualization of parts of the laryngeal aperture of the arytenoids.

Grade III: Visualization of only the epiglottis.

Grade IV: Visualization of only the soft palate.

Cormack-Lehane grade I and II was categorized as easy laryngoscopy; and grade III or IV, as difficult laryngoscopy [11-14].

Statistical analysis

It was performed by using SPSS (version 22, SPSS, Chicago, IL, USA). The correlation between independent quantitative and qualitative variables was assessed with the t-test. The correlation between nominal and qualitative variables was assessed using the Chi-square test. Correlation coefficient and regression analyses were used for quantitative variables. For calculation of specificity and sensitivity, Receiver operating characteristic (ROC) was used. A $p < 0.05$ was accepted as statistically significant.

Results

Of the 65 consecutive patients enrolled in the study five were excluded due to using regional anesthesia or intravenous sedation. A total of sixty patients were analyzed. Demographic data and Cormack-Lehane grade of the patients are presented in (Tables 1 and 2).

No patient had Cormack-Lehane grade IV. It was observed that the correlation between CL grade and distance from skin to epiglottis (DSE) with cutoff value 21mm (with an accuracy of 99%, a sensitivity of 100%, and a specificity of 82% ; $P=0.0001$) and from epiglottis

to mid vocal cord distance (EMVD) with cutoff value 13.38 (with an accuracy of 99%, a sensitivity of 100%, and a specificity of 85% ; $P=0.01$) and the ratio of DSE/EMVD with cutoff value 1.64 (with an accuracy of 95%, a sensitivity of 100%, and a specificity of 91% ; $P=0.004$) was significant for predicting of difficult intubation in patients with $BMI > 25$.

Table 1- Demographic and base line characteristics of patients

Variables	Values*
Male/female	38/22
Age (y)	39.8±12.5
Weight(kg)	75.4±14.4
Height(cm)	171.0±10.1
BMI(kg/m ²)	26.4±4.7
ASA Class I/II/III	37/21/2

* Values are expressed as ratio or mean ± SD

Table 2- Frequency of Cormack-Lehane grades in the study patients

Cormack-Lehane grade	Number of patients
Grade I	36
Grade II	21
Grade III	3
Grade IV	0

Discussion

Anatomical criteria that have been introduced for preoperative airway evaluation are not applicable in emergency settings or in uncooperative and unconscious patients. Furthermore, the Cormack-Lehane grade does not always correlate with the abovementioned criteria. Therefore, the use of other accurate and non-invasive method is necessary. The introduction of anatomical evaluation with US imaging has been one of the most exciting recent technological advances in the field of anesthesia. The increasing use of US has been attributed to its proven clinical efficacy, cost effectiveness and practicality as it allows anesthesiologists to evaluate complex and varied anatomy [13-14].

In a study by Pinto et al. on 74 adult patients requiring tracheal intubation they found that increasing DSE was strongly associated with difficult laryngoscopy ($P < 0.001$, 2-sided t test). They showed that a cutoff value of 27.5mm was able to predict difficult laryngoscopy with an accuracy of 74.3%, a sensitivity of 64.7%, and a specificity of 77.1%. Their study was correlated to ours in which increasing DSE are associated with difficult intubation although our cutoff value was less (21mm vs 27.5 mm) [8].

In a study by Gupta et al. in 2012 on 72 patients undergoing general anesthesia, significant correlations

were found between Cormack-Lehane grade and sonographic measurements, peri-epiglottic space (PE) and the distance from the epiglottis to the vocal cords (PE/E-VC). They found that the higher the PE/E-VC ratio, the stronger the possibility of a higher Cormack-Lehane grade on direct laryngoscopy and of difficult intubation. Although we used DSE instead of PE measurement, our results was in line with their study in which the ratio of DSE/EMVD with cutoff value 1.64 (with an accuracy of 95%, a sensitivity of 100%, and a specificity of 91%; $P=0.004$) was significant and increasing the ratio was associated with higher Cormack-Lehane grade on direct laryngoscopy and useful for predicting difficult intubation [9].

In our previous study on 53 patients undergoing general anesthesia and tracheal intubation we found that correlations between the pre-epiglottic space (PE) and Cormack-Lehane grades I, II, and III were weak. Correlations between the distance from the epiglottis to the mid-vocal cords (E-VC) and Cormack-Lehane grades I, II, and III were also weak. The PE/E-VC ratio for correlations between the sonographic view and laryngoscopy had 87.5% sensitivity and 30% specificity. In this regard we conducted a new study with an easier and practical measurement of DSE instead of PE and to find any correlation between the DSE/EMVD ratio and CL grade for predicting difficult intubation [10].

Conclusion

Our study showed good correlation between DES/EMVC ratio and Cormack-Lehane grade in which increasing DSE and the mentioned ration are associated with increased risk of difficult intubation. Therefore sonographic measurement criteria may be helpful in airway evaluations before anesthesia for predicting of difficult intubation.

Acknowledgements

We appreciate anesthesia staff of operating room of Dr Shariati hospital for their kind support.

References

- [1] Cook TM, Woodall N, Harper J, Benger J. Major complications of airway management in the UK: results of the fourth national audit project of the royal college of anaesthetists and the difficult airway society. Part2: intensive care and emergency departments. *Br J Anaesth.* 2011; 106(5): 632–642.
- [2] 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.
- [3] Lundstrom LH, Vester-Andersen M, Moller AM, Charuluxananan S, L'Hermite J, Wetterslev J, et al. Poor prognostic value of the modified Mallampati score: a meta-analysis involving 177 088 patients. *Br J Anaesth.* 2011; 107(5):659–67.
- [4] Sustic A. Role of ultrasound in the airway management of critically ill patients. *Crit Care Med.* 2007; 35:173–7.
- [5] Singh M, Chin KJ, Chan VW, Wong DT, Prasad GA, Yu E. Use of sonography for airway assessment: An observational study. *J Ultrasound Med.* 2010; 29(1):79–85.
- [6] Tsui BC, Hui CM. Sublingual airway ultrasound imaging. *Can J Anaesth.* 2008; 55(11):790–1.
- [7] Tsui BC, Hui CM. Challenges in sublingual airway ultrasound interpretation. *Can J Anaesth* 2009; 56(5):393–4.
- [8] Pinto J, Cordeiro L, Pereira C, Gama R, Fernandes HL, Assunção J. Predicting difficult laryngoscopy using ultrasound measurement of distance from skin to epiglottis. *J Crit Care.* 2016; 33:26–31.
- [9] Gupta D, Srirajakalidindi A, Itiara B, Apple L, Toshniwal G, Haber H. Ultrasonographic modification of Cormack Lehane classification for pre-anesthetic airway assessment. *Middle East J Anaesthesiol.* 2012; 21(6):835–42.
- [10] Soltani Mohammadi S, Saliminia A, Nejatifard N, Azma R. Usefulness of Ultrasound View of Larynx in Pre-Anesthetic Airway Assessment: A Comparison with Cormack-Lehane Classification During Direct Laryngoscopy. *Anesth Pain Med.* 2016; 6(6):e39566
- [11] Adhikari S, Zeger W, Schmier C, Crum T, Craven A, Frrokaj I, et al. Pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy. *Acad Emerg Med.* 2011; 18(7):754–8.
- [12] Bajracharya GR, Truong AT, Truong DT, Cata JP. Ultrasound-Assisted Evaluation of the Airway in Clinical Anesthesia Practice: Past, Present and Future. *Int J Anesthesiol Pain Med.* 2015; 1(1):1–2
- [13] Gupta PK, Gupta K, Dwivedi AN, Jain M Potential role of ultrasound in anesthesia and intensive care. *Anesth Essays Res.* 2011; 5(1):11–19.
- [14] Bright L, Secko M, Mehta N, Paladino L, Sinert R. Is there a correlation of sonographic measurements of true vocal cords with gender or body mass indices in normal healthy volunteers? *J Emerg Trauma Shock.* 2014; 7(2): 112–5.