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Anatomical location of the vocal cords in relation to cervical vertebrae, a new predictor of difficult laryngoscopy: A descriptive cross sectional study

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ABSTRACT

Background: Airway management is among the challenges faced by the anaesthesiologists. There are anatomical and clinical factors, which can predict the difficult laryngoscopy. In this study, the aim was to predict the easy and difficult laryngoscopy preoperatively by assessing the anatomy of patient's head and neck. The objective was to assess the same by using the magnetic resonance imaging films of the neck.
Materials and Methods: The study included 110 adult patients with existing preoperative magnetic resonance imaging scans of neck. Preoperative anaesthetic assessment was done by using the thyromental distance, sternomental distance, body weight, mouth opening, Mallampati classification and head neck movement. The magnetic resonance imaging scans were screened for slices to visualise the vocal cords. A projection line was drawn to determinethe topography of vocal cords in relation to the cervical vertebrae. The ease of laryngoscopy by Cormack-Lehane grade was then correlated with the vertebral level of the vocal cords.
Results: The laryngoscopy was difficult in over weight patients ($p<0.001$) and with smaller thyromental distance. It was also observed that the laryngoscopy was easy ($p<0.001$), when the topographical location of vocal cords were related to C5 and hard, when they are at the level of C4 and C6 ($p<0.001$).
Conclusion: Magnetic resonance imaging films of neck could be used to evaluate the potential difficult laryngoscopy, preoperatively. It can be used along with the existing bedside tests like determination of thyromental distance, sternomental distance and modified Mallampati classification.

1. Introduction

The management of airway is considered as one of the responsibility of anaesthesiologists. Disastrous anoxic injury can occur if it is failed to maintain oxygenation for more than a few minutes. Difficult endotracheal intubation could lead to morbidity and mortality due to anaesthetic procedure.[1–3] Difficulty to provide mask ventilation and intubate the trachea is defined as the difficult airway. During the preoperative anaesthetic check-up, the prediction of possible difficult airway situations needs to be addressed.[4] The precise examination of the patient's head and neck anatomy is important. However regular preoperative clinical assessment test does not always assess the probability of easy and difficult laryngoscopy in every patients, even with typical orofacial anatomic features.

There are few individual indices and group indices, which can predict the difficult airway. However, there is no single index, which can predict the difficult laryngoscopy and intubation with 100% accuracy, unless there is pathology or gross abnormality. Multiple tests are done to increase the difficult airway predictability

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chances. The studies, which used the imaging techniques to find the anatomical predictors of difficult laryngoscopy, are limited and most of them used the conventional radiograph techniques. The limitations of radiographs include radiolucent soft tissue and cartilage structures.[5–7] The magnetic resonance imaging (MRI)can provide better means of studying the complex airway anatomy and help in identifying the potential indicators of harder laryngoscopy and endotracheal intubation.In this context, the aim of this study was to preoperatively assess the patient by using the Mallampati classification, thyromental distance, sternomental distance, body weight, mouth opening and head neck movement for the easy and difficult laryngoscopy. The objective was to determine the topographical relation of vocal cords with respect to the cervical vertebrae level and to correlate it with easy and difficult laryngoscopy.

2. Materials and Methods

2.1. Study design, study setting, and study sample

This investigation is a descriptive cross-sectional study, which involved110 patients with existing preoperative MRI films of neck and cervical spine. They were above 18 years of age and patients with obvious cervical spine injuries, restricted head movements, with history of acromegaly, ear, nose, throat tumours, and restricted mouth opening of less than 3 cm were excluded from the present study. The patients with history of contraindications to direct laryngoscopy were also excluded. After taking clearance from ethics committee, patients who satisfy inclusion criteria and consented for the study were included. Patients were evaluated during their pre-anaesthetic visit. The age, gender, stature, weight and physical status were documented.

2.2. Data collection

The patients were asked to open the oral cavity as much as possible. Mouth opening of less than two fingers was considered as difficult airway.

2.3. Modified mallampati classification (Figure 1)

The patients were asked to sit and look straight with mouth wide open and tongue protruded. They are advised not to speak during the examination to prevent the movement of soft palate, which can lead to error.[8] Mallampati classification[9] uses the inspection of soft palate and boundaries of tonsillar fossa. The present study followed modified Mallampati classification, according to Samsoon and Young.[10]

Class I: Anterior and posterior tonsillar pillars, soft palate, uvula, all seen (Figure 1 A)

Class II: Only base of uvula and soft palateare visible (Figure 1 B)

Class III: Only soft palate is observed (Figure 1 C)

Class IV: These are all not seen, buthard palate is observed (Figure 1 D)

The class I and II of this classification were considered as easy laryngoscopy. The difficult laryngoscope included class III and class IV.

2.4. Thyromental distance (TMD)

TMD is measured between lower border of chin to the thyroid notch of laryngeal prominence with fully extended neck and mouth closed.[11] This was considered as difficult laryngoscopy if TMD was less than 6.5 cm and easy laryngoscopy if it is more.

2.5. Sternomental distance (SMD)

This measurement was performed between the jugular notch to the chin with fully extended neck and closed mouth.[12] If SMD is less than 13.5 cm, it is considered as difficult laryngoscopy and easy if it is more than that.

2.6. Radiological assessment

Existing MRI images (1.5 Tesla Siemens Magnetomavanto) of neck and cervical spine were screened for the slices in which the vocal cords could be identified. A projection line was plotted to determine the topographical location of vocal cords with respect to the vertebral level. The images were categorised as C_3-C_4 interspace, body of C_4 vertebra, C_4-C_5 interspace, body of C_5 vertebra, C_5- C_6 interspace and body of C_6 vertebra.

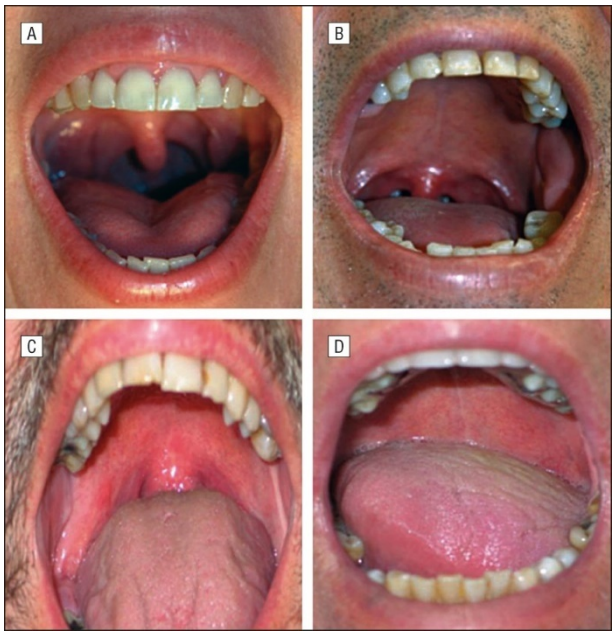

Fig. 1: Modified mallampati classification (1A-class I; 1B-class II; 1C-class III; 1D-class IV)

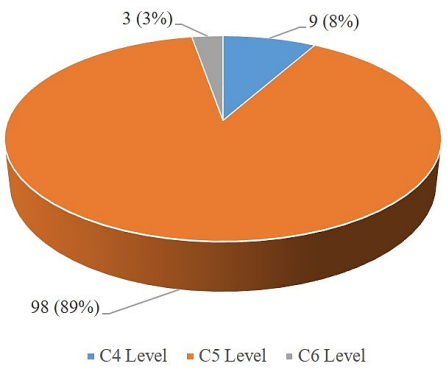

Fig. 2: Distribution of patients in terms of location of vocal cords with respect to cervical spine level (n = 110)

Figure 3 MRI films of neck showing the topography of vocal cords (marked as red line -) in relations to the cervical spine, 3A-vocal cords related to C4 level (8.2% cases), 3B-vocal cords related to C5 vertebra (89.1% cases) and 3C-vocal cords related to C6 (2.7%).

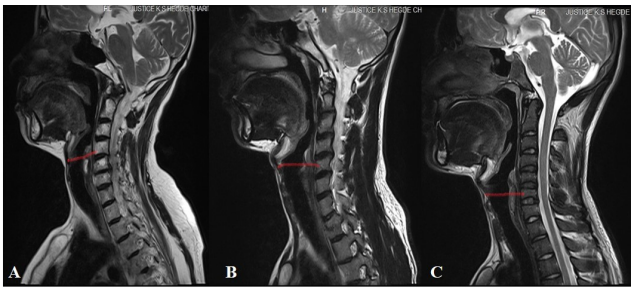

Fig. 3: MRI films of neck showing the topography of vocal cords (marked as red line -) in relations to the cervical spine, 3A-vocal cords related to C4 level (8.2% cases), 3B-vocal cords related to C5 vertebra (89.1% cases) and 3C-vocal cords related to C6 (2.7%)

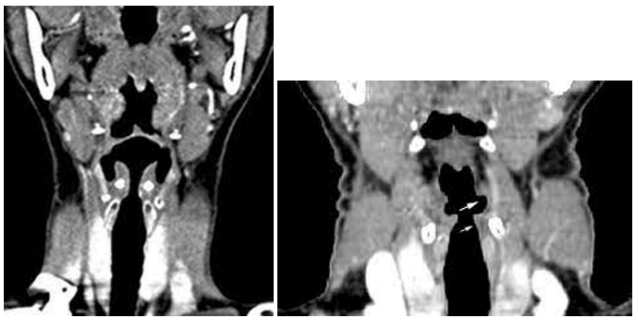

Fig. 4: MRI correlation

2.7. Correlation of easy and difficult laryngoscopy

Standard institutional protocol for fasting and premedication was followed. On table in operation theatre, standard minimum required monitors were attached and patients were preoxygenated with 100% O_2, then anaesthesia was induced and paralysed. When TOF was equal to 0, direct laryngoscopy was perfomed with appropriate size Macintosh blade with patients head positioned in sniffing position. The glottis view was graded as per Cormack-Lehane(CL) grading system. CL grade 1 and 2 are categorized into easy laryngoscopy group, CL grade 3 and 4 are difficult laryngoscopy group. Topographical location of the vocal cords and vertebral level are correlated with ease of laryngoscopy.

2.8. Statistical analysis

Data was presented as percentage and proportion. Continuous data were tested for differences between the two groups (easy vs. difficult laryngoscopy) using the‘t’ test for unpaired samples or the Mann–Whitney test. Categorical data were tested for difference between two groups using the ‘x2’ or ‘Fisher’s exact test’. Spearman correlation test was used for determining correlation between topography of vocal cords with respect to the vertebral level and ease of laryngoscopy. The comparison is considered as statistically significant only if the ‘p’ value is smaller than 0.05.

Finite population: $n' = \dfrac{n}{1+\dfrac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$

Where,

z is the z score

ε is the margin of error

N is the population size

$\hat{p}$ is the population proportion

This means 110 or more measurements/surveys are needed to have a confidence level of 95% that the real value is within ±5% of the measured/surveyed value.

3. Results

3.1. Age

In the present study, the age group of the patients was ranging between 24 and 71 years. The mean age was 53.75 ± 10.7 years. It was observed that the laryngoscopy was difficult in the elderly individuals than the younger (p = 0.001). The difficult laryngoscopy group was having the mean age of 62.17 ± 8.18 years.

3.2. Gender

In the total participants 71 (64.5%) were male and 39 (35.5%) were females. There was no significant difference (Table 1) with ease of laryngoscopy in terms of distribution

Table 1: Association between ease of laryngoscope and gender (n=110)

Gender	Ease of Laryngoscopy (Cormack-Lehane Grade)			Fisher's Exact Test	
	Easy	Difficult	Total	X^2	P Value
Male	61 (55.4%)	10 (9.1%)	71 (64.5%)	2.078	0.207
Female	37 (33.7%)	2 (1.8%)	39 (35.5%)		

Table 2: Correlation of modified Mallampati classification with ease of laryngoscope (n=110)

Modified Mallampati Classification	Ease of Laryngoscopy (Cormack-Lehane Grade)			Fisher's Exact Test	
	Easy	Difficult	Total	X^2	P Value
Class I	47 (42.7%)	1 (0.9%)	48 (43.6%)		
Class II	50 (45.4%)	9 (8.2%)	59 (53.6%)	14.590	0.003
Class III	1 (0.9%)	2 (1.8%)	3 (2.7%)		
Class IV	nil	nil	nil		

of gender (p = 0.207).

3.3. Modified mallampati classification (MMC)

In our study (Table 2) 43.6% of the participants belonged to MMC class 1, 53.6% had class 2 and 2.7% of the participants had MMC class 3 and no participants with class 4 (0%). There was statistical significance among the comparison between the easy and difficult laryngoscopy group as per modified Mallampati Class (p = 0.003). Among MMC class I and II (Table 2), more than 88% had easy laryngoscopy. The MMC class III, 67% had difficult laryngoscopy.

3.4. Topographical location of vocal cords with respect to the cervical spine as per MRI

The frequency of vertebral level of vocal cords is represented in Figure 2. The MRI pictures of neck of the patients of present study are given in Figure 3. In 89.1% of the participants, the vocal cords were anteriorly related to body of fifth cervical vertebra (Figure 3 B), 8.2% related to the fourth cervical vertebra(Figure 3 A) and 2.7% of the cases had vocal cords relating to the sixth cervical vertebra (Figure 3 C). The present study observed that the laryngoscopy was easier if the vocal cords were located at C5 level and this was hard if the vocal cords are located at C4 and C6 levels (Table 3, Cormack-Lehane Grade, p<0.001).

3.5. Cormack-Lehane (CL) grade

In the present study, 65.5% of the participants belonged to first grade of CL, 23.6% were grouped as CL grade 2 and the remaining 10.9% cases, came under grade 3 of CL.

3.6. Thyromental distance (TMD)

In the present study, the thyromental distance ranged between 6.8 to 11 cm. The mean thyromental distance in easy and difficult laryngoscope group was 9.06 ± 0.93 cm and 7.48 ± 0.90 cm respectively. This comparison was statistically significant. The laryngoscopy was difficult in people with smaller thyromental distance (p = 0.001).

3.7. Sternomental distance

The mean sternomental distance in this study was 15.66 ± 1.17cms. There was a statistical significance between easy and difficult laryngoscopy in terms of sternomental distance (p<0.001). The mean sternomental distance was 15.82 ± 1.12 and 14.35 ± 0.61 in easy and difficult laryngoscopy respectively. The laryngoscopy was difficult in people with smaller sternomental distance.

3.8. Weight

The mean weight was 56.15 ± 8.59kgs, of the total participants. The mean weight in the easy laryngoscopy group was 54.12 ± 5.38kgs. This was 72.67 ± 11.86kgs in the difficult laryngoscopy group. The laryngoscopy was difficult in people with increased weight, chi-square statistic is 0.0394. The p-value is .842649. The result is not significant at p < .05.

3.9. Height

The height among the participants ranged from 1.45 to 1.78 metres with mean height being 1.62 ± 0.06 metres. The mean height in the easy laryngoscopy group was 1.63 ± 0.06 metres and difficult laryngoscope group was 1.59 ± 0.07 metres respectively. There was no significant difference with ease of laryngoscopy (Cormack-Lehane Grade) in terms of height. The chi-square statistic is 0.6667. The p-value is .414216. The result is not significant at p < .05.

3.10. Body mass index(BMI)

The mean BMI among the participants in our study was 21.37 ± 3.34 kg/m^2. Comparison of ease of laryngoscopy (Cormack-Lehane Grade) in terms of easy and difficult laryngoscope being 20.48 ± 1.88 kg/m^{2}and 28.63 ± 3.88

Table 3: Association between ease of laryngoscope and topography of vocal cords (n=110)

Ease of Laryngoscopy (Cormack-Lehane Grade)	C4	C5	C6	Fisher's Exact Test X^2	p value
Easy	nil	98 (100%)	nil	110.000	<0.001
Difficult	9 (100%)	nil	3 (100%)		

Table 4: Weight

	Weight			Chi Square Test
	Easy	Difficult	Total	P Value
Mean	54.12 ± 5.38kgs	72.67 ± 11.86kgs	56.15 ± 8.59kgs	.842649

Table 5: Height

	Height			Chi Square Test
	Easy	Difficult	Total	P Value
Mean	1.63 ± 0.06	1.59 ± 0.07	1.62 ± 0.06 metres	.414216

Table 6: Body mass index

	Body Mass Index			Chi Square Test
	Easy	Difficult	Total	P Value
Mean	20.48 ± 1.88 kg/m^2	28.63 ± 3.88 kg/m^2	21.37 ± 3.34 kg/m^2	.049248

kg/m^2 respectively. This was a significant difference with ease of laryngoscopy in terms of BMI. The laryngoscopy was difficult in people with increased BMI. The chi-square statistic is 0.4711. The p-value is .049248. The result is significant at $p < .05$.

4. Discussion

Larynx is the organ of phonation, which is also known as voice box. It is the beginning of lower respiratory tract and situated in front of laryngopharynx in the anterior midline of the upper part of the neck. It extends from the root of the tongue to the trachea and lies in front of 3rd to 6th cervical vertebrae. Anaesthetic gases are carried to the alveoli along these air passages as an anaesthesiologist inserts endotracheal tube into the upper and lower respiratory tract, which provides proper airway management. If the direct laryngoscopy is taking more than 3 attempts or greater than 10 minutes to perform, is considered as difficult laryngoscopy.[13–15] Failure to intubate and difficulty intubation can cause morbidity and mortality to the patients.[13–15] Preoperative airway examination will help in arranging the facilities like ventilation in anticipation of difficult intubation. Magnetic resonance imaging (MRI) was not used routinely to assess the airway. In this study, we propose to correlate the vertebral level of vocal cords with ease of laryngoscopy using CL grading system. In our study, 89.1% of the patients had vocal cords anterior to the C5 and these patients had easier laryngoscopy. This is found to be in concurrence with the observations of Tino Munster et al.[16] who found that in patients with difficult laryngoscopy the vocal cords were positioned more cranially in relation to cervical spine. We observed a statistical significance in patients having easy laryngoscopy compared with patients having difficult laryngoscopy with respect to their age. The age of the participants with difficult laryngoscopy was 39 to 69 years, which was similar to study conducted by Hyoung-Yong Moon[17] and his colleagues. In their study 40-59 years was the age group for the difficult intubation. Ezri et al.[18] reported that, with the increasing age the airway classes and the laryngoscopy grades also increase, this may be due to alterations in the bony joint anatomy and bad teeth. Obesity and overweight are considered as the risk factors and these patients are prone for difficult laryngoscopy. This is noticed in our study that there was a statistical significance between weight, BMI and difficult laryngoscopy. The mean weight and BMI of the participants with difficult laryngoscopy was 72.67±11.86 kgsand 28.63 ± 3.88 kg/m2 respectively, which was slightly higher than the observations by Prakash et al.20However Prakash et al.[19] did not observe the association between body mass index and difficult laryngoscopy. The comparison of different age groups, gender, different weightsand heights did not reveal statistically significant difference among easier and difficult laryngoscopy groups in the study by Savva.[20]

The exposure of larynx by direct laryngoscopy depends on the proportionality of the tongue in relation to oropharynx. The visibility of glottis becomes easy, when the size of base of tongue is proportional to the size of oropharyngeal isthmus and no obvious pathology. A larger base of tongue may not allow to visualize the laryngeal inlet. Mallampati et al.[9] found that, it is possible to predict the difficult laryngoscopy by inspecting the oropharyngeal

isthmus. Modified Mallampati classification correlates the dimensions of tongue with the oropharynx and oral cavity. In our study, it was found that 2.7% of the participants with MMC class 3 and they all had difficult laryngoscopy. It is noticed in our study that there was statistical significance between TMD, SMD and difficult laryngoscopy. The mean TMD in our study was 8.88± 1.04 cm, which is similar to the findings of Schmitt et al.,[21] who opined that the ratio of stature of individual to the TMD need to be calculated. This gives better prediction than TMD alone for the ease of laryngoscopy.

The sternomental distance (SMD) will provide knowledge about the head and neck movement. The cut off value for predicting difficult laryngoscopy is 13.5 cm.[12] The mean SMD in our study was 15.66±1.17 cm, which was slightly more than the data reported by Al Ramadhaniet al.[12] Al Ramadhani et al.[12] concluded that SMD alone can be used as a predictive test, however this should be among the examination methods. Kamalipour et al.[17] compared the Mallampati classification with several anatomical angles obtained from preoperative radiographs of lateral neck. In radiographs, there are several parameters, which can be measured to report it as easy or difficult intubation. The analysis of lateral view radiograph is found to be better than Mallampati classification to predict the difficult intubation. Chou and Wu[6] evaluated lateral cervical radiographs in patients who had difficult laryngoscopy in the operation theatre. The perpendicular distance between the hyoid bone and mandible was measured. The topographical location of angle of mandible and hyoid bone were analysed in relation to cervical spine. They reported that smaller ramus of mandible and inferiorly placed vocal cords could cause difficulty in intubation. Bellhouse and Dore[5] reported that reduction of atlanto-occipital joint extension, thickness of tongue and proportion of mandibular space can predict the difficult laryngoscopy.

Gupta and Gupta[18] measured the maxillo-pharyngeal angle on a lateral cervical radiograph and later correlated with easy or difficult laryngoscopy. The direct laryngoscopy was found difficult in patients with maxillo-pharyngeal angle less than 90° and they all had grade III and IV Cormack and Lehane grading. Naguib et al.[22] compared Mallampati classification with radiological data such as depth of spine of axis and antero-inferior point of the upper central incisor. They found that combined clinical data and radiological data analysis gave a better picture to predict difficult airway when compared to clinical data alone to predict difficult airway. Samra et al.[23] compared soft tissue radiographs with MRI scans of neck, but found that there was no significant difference. Stefano Falcetta et al.[24] compared the correlation between sonographic measurements of soft tissues thickness of anterior part of neck and Cormack-Lehane grading. They opined that ultrasound can predict difficult laryngoscopy but not difficult endotracheal intubation. Yongzheng et al.[25] measured distance between skin to vocal cords by using both MRI and ultrasound, but these variables could not predict difficult laryngoscopy. Leeet al.[26] compared the measurements of retropharyngeal space with respect to vertebral level and comparison was done with difficult and easy laryngoscopy. They opined that, traumatic cervical spine injury at the upper level with retropharyngeal extension could lead to difficult laryngoscopy and intubation.

Smita et al.[19] reported the prevalence of difficult laryngoscopy and endotracheal intubation as 9.7% and 4.5% in Indians. Tino Munster et al.[16] found that laryngoscopy was easy in 64.1% of their patients and difficult in 35.9% cases (CL 3 or 4). In this study, difficult laryngoscopy was determined as 10.9% of cases. Kheterpal et al.[27] demonstrated that age over 46 years, BMI more than 30kg/m2, male sex and Mallampati classification 3 or 4 are predictors of difficult laryngoscopy. These results emphasise the fact that there is no single predictor for the difficult laryngoscopy.

In this research study, it is observed that, vocal cords positioned at 4th and 6th cervical spine are prone for difficult laryngoscopy. The patients with easy laryngoscopy had the vocal cords positioned at 5th cervical spine. Majority of the patients with difficult laryngoscopy had superiorly placed vocal cords in relation to cervical spine. We propose that the MRI neck can be used to predict the ease of laryngoscopy, but the limitations is the cost of getting a MRI scan, which can't be done on a routine basis in all patients because few patients might not be able to afford the cost of undergoing a MRI. The MRI is also a time consuming diagnostic modality. It is challenging to sedate or give general anaesthesia in paediatric population and in patients with claustrophobia, in whom the airway has to be protected. The scanning of airway structures in MRI is also compromised because of the breathing motion artefact and limited resolution. Because of the higher cost and time consumability, we do not advice their use for the routine MRI imaging to assess the possibility of difficult airway. However with existing MRI images preoperatively, it is necessary to include MRI scan findings in evaluating the possibility of difficult laryngoscopy in addition to the other bedside tests. Furthermore studies are needed to know the possibility of difficult laryngoscopy and intubation using MRI images.

We evaluated the MRI images, which may play a significant role in predicting the difficult laryngoscopy. The present study also used other clinical parameters to predict the difficult laryngoscopy like height, weight, BMI, thyromental distance, sternomental distance and modified Mallampati classification, which had significant correlation with difficult laryngoscopy except for height and gender. It is opined that the preoperative MRI can be used along with

the other predictors of difficult laryngoscopy. However, the MRI of necks can be utilized only if they are available and the anaesthesiologists alone should not advise them.

5. Source of Funding

None.

6. Conflict of Interest

We state that there are no relationships, circumstances and conditions that have potential conflicts of interest associated with this manuscript.

7. Ethical Approval

This study has been approved by the institutional ethics committee of K.S. Hegde Medical Academy, Constituent College of Nitte University (INST.EC/EC/089/2017-18).

References

1. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: a closed claims analysis. *Anesthesiology*. 1990;72(5):828–33.
2. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. *Anesthesiology*. 2005;103(1):33–9.
3. Cook TM, Woodall N, Frerk C. 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. Part 1: anaesthesia. *Br J Anaesth*. 2011;106(5):617–31.
4. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, et al. Practice Guidelines for Management of the Difficult Airway: An Updated Report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2003;98(5):1269–77.
5. Bellhouse CP, Dore´C. Criteria for estimating likelihood of difficulty of endotracheal intubation with the Macintosh laryngoscope. *Anaesth Intensive Care*. 1988;16(3):329–37.
6. Chou HC, Wu TL. Mandibulohyoid distance in difficult laryngoscopy. *Br J Anaesth*. 1993;71(3):335–9.
7. Samra SK, Schork MA, Guinto FC. A study of radiologic imaging techniques and airway grading to predict a difficult endotracheal intubation. *J Clin Anesth*. 1995;7(5):373–9.
8. Mashour GA, Kheterpal S, Vanaharam V, Shanks A. The extended Mallampati score and a diagnosis of diabetes mellitus are predictors of difficult laryngoscopy in the morbidly obese. *Anesth Analg*. 2008;107(6):1919–23.
9. Mallampati SR, Gatt SP, Gugino LD, Desai SP. A clinical sign to predict difficult tracheal intubation: a prospective study. *Can Anaesth Soc J*. 1985;32(4):429–34.
10. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. *Anaesthesia*. 1987;42(5):487–90.
11. Patil VU, Stehling LC, Zauder HI. Predicting the difficulty of intubation utilizing an intubation gauge. *Anaesthesiol Rev*. 1983;10:32–3.
12. Ramadhani SA, Mohamed LA, Rocke DA, Gouws E. Sternomental distance as the sole predictor of difficult laryngoscopy in obstetric anaesthesia. *Br J Anaesth*. 1996;77(3):312–6.
13. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2013;118(2):251–70.
14. Gupta S, Sharma K, Jain D. Airway assessment: predictors of difficult airway. *Indian J Anaesth*. 2005;49(4):257–62.
15. Karkouti K, Rose DK, Wigglesworth D, Cohen MM. Predicting difficult intubation: a multivariable analysis. *Can J Anesth*. 2000;47(8):10958088–10958088.
16. Münster T, Hoffmann M, Schlaffer S, Ihmsen H, Schmitt H, Tzabazis A. Anatomical location of the vocal cords in relation to cervical vertebrae: A new predictor of difficult laryngoscopy. *EurJ Anaesthesiol*. 2016;33(4):257–62.
17. Moon HY, Baek CW, Kim JS, Koo GH. The causes of difficult tracheal intubation and preoperative assessments in different age groups. *Korean J Anesthesiol*. 2013;64(4).
18. Ezri T, Warters RD, Szmuk P, Saad-Eddin H. The incidence of class "zero" airway and the impact of Mallampati score, age, sex, and body mass index on prediction of laryngoscopy grade. *AnesthAnalg*. 2001;93(4):11574386–11574386.
19. Prakash S, Kumar A, Bhandari S, Mullick P, Singh R, Gogia AR. Difficult laryngoscopy and intubation in the Indian population: An assessment of anatomical and clinical risk factors. *Indian JAnaesth*. 2013;57(6):24403616–24403616.
20. Savva D. Prediction of difficult tracheal intubation. *Br J Anaesth*. 1994;73(2).
21. Schmitt HJ, Kirmse M, Radespiel&#8209, Troger M. Ratio of patient's height to thyromental distance improves prediction of difficult laryngoscopy. *Anaesth Intensive Care*. 2002;30(6).
22. Kamalipour H, Bagheri M, Kamali K, Taleie A, Yarmohammadi H. Lateral neck radiography for prediction of difficult orotracheal intubation. *Eur JAnaesthesiol*. 2005;22(9):16163916–16163916.
23. Gupta K, Gupta PK. Assessment of difficult laryngoscopy by electronically measured maxillo-pharyngeal angle on lateral cervical radiograph: A prospective study. *Saudi J Anaesth*. 2010;4(3).
24. Naguib M, Malabarey T, Alsatli RA, Damegh A, Samarkandi S, H A. Predictive models for difficult laryngoscopy and intubation. A clinical, radiologic and three-dimensional computer imaging study. *Can J Anaesth*. 1999;46(8):748–59.
25. Iohom G, Ronayne M, Cunningham AJ. Prediction of difficult tracheal intubation. *Eur J Anaesthesiol*. 2003;20(1):12553386–12553386.
26. Falcetta S, Cavallo S, Gabbanelli V, Pelaia P. Evaluation of two neck ultrasound measurements as predictors of difficult direct laryngoscopy: A prospective observational study. *Eur J Anaesthesiol*. 2018;35(8):29889671–29889671.
27. Kheterpal S, Healy D, Aziz MF, Shanks AM. Multicenter Perioperative Outcomes Group (MPOG) Perioperative Clinical Research Committee. Incidence, predictors, and outcome of difficult mask ventilation combined with difficult laryngoscopy: a report from the multicenter perioperative outcomes group. *Anesthesiology*. 2013;119(6):24071617–24071617.

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