Section: Anaesthesia

Original Research Article

EVALUATION OF SKIN TO EPIGLOTTIS VERSUS SKIN TO VOCAL CORD DISTANCE IN PREDICTING DIFFICULT AIRWAY AMONG PATIENTS SCHEDULED FOR ELECTIVE SURGERY – A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Unanticipated difficult airway remains a major concern in anaesthesia practice because failure to secure the airway can lead to serious complications such as hypoxia, aspiration, airway trauma, and mortality. Conventional clinical airway assessment methods have limited predictive value and are often unreliable when used alone. Ultrasonography has recently gained importance as a non-invasive bedside tool for airway evaluation. Among the various ultrasonographic parameters, skin to epiglottis distance (DSE) and skin to vocal cord distance (DVC) have shown promising utility in predicting difficult intubation. The aim is to evaluate and compare skin to epiglottis distance and skin to vocal cord distance in predicting difficult airway among patients undergoing elective surgery under general anaesthesia.

Materials and Methods: This prospective observational study was conducted in the Department of Anaesthesia at Indira Gandhi Medical College and Research Institute, Puducherry, over a period of 18 months from June 2023 to November 2024. A total of 106 adult patients scheduled for elective surgery under general anaesthesia were included. Preoperative ultrasonographic measurements of DSE and DVC were obtained using a linear ultrasound probe. Difficult intubation was assessed intraoperatively using the Intubation Difficulty Scale (IDS). Patients with IDS score greater than 5 were categorized as having difficult intubation. Receiver operating characteristic curve analysis was used to determine cutoff values and diagnostic accuracy.

Results: Difficult intubation was observed in 5 patients (4.7%). DSE showed statistically significant association with difficult intubation with a cutoff value of ≥2.36 cm, sensitivity of 80%, specificity of 92.08%, and diagnostic accuracy of 91.51%. DVC also demonstrated statistical significance with a cutoff value of ≥0.7 cm, sensitivity of 80%, specificity of 64.36%, and diagnostic accuracy of 65.09%.

Conclusion: Skin to epiglottis distance is a superior ultrasonographic predictor of difficult airway compared to skin to vocal cord distance.

Keywords: Difficult Airway, Ultrasonography, Skin-to-Epiglottis Distance, Skin-to-Vocal Cord Distance, Airway Assessment,Elective Surgery.

INTRODUCTION

Airway management remains one of the most critical responsibilities of an anaesthesiologist, and failure to identify a difficult airway may lead to serious complications including hypoxia, aspiration, airway trauma, cardiac arrest, and even death. Accurate preoperative prediction of difficult airway continues

to be a major challenge despite the availability of several bedside screening tests. Conventional clinical predictors such as Modified Mallampati classification, thyromental distance, sternomental distance, upper lip bite test, and neck mobility assessment are commonly used; however, their sensitivity and specificity remain inconsistent when used alone. Therefore, the search for a reliable, non-invasive, and reproducible method for airway assessment continues.[1]

Point-of-care ultrasonography has emerged as a valuable bedside tool in anaesthesia practice due to its portability, safety, real-time imaging capability, and non-invasive nature. In recent years, airway ultrasound has gained increasing attention for the evaluation of upper airway anatomy and prediction of difficult laryngoscopy and intubation. Ultrasound can visualize anatomical structures such as the tongue, epiglottis, vocal cords, and anterior neck soft tissues with good accuracy. Among various ultrasonographic parameters, the distance from skin to epiglottis (DSE) and distance from skin to vocal cords (DVC) have shown promising results in predicting difficult airway.[2]

Several studies have demonstrated that increased anterior neck soft tissue thickness measured by ultrasound is associated with difficult laryngoscopy. Fernandez-Vaquero et al. reported that DSE was a significant predictor of difficult intubation with high sensitivity and specificity.[3] Similarly, Tasdemir et al. found ultrasound-based airway assessment particularly useful in obese patients for identifying difficult airway.[4] Kose et al. also concluded that DSE was one of the most reliable ultrasonographic predictors among different airway measurements.[5] Although DVC has also been evaluated as a predictor of difficult airway, evidence regarding its diagnostic accuracy remains limited and variable across studies. Hence, the present study was undertaken to evaluate and compare skin to epiglottis distance and skin to vocal cord distance in predicting difficult airway among patients undergoing elective surgery under general anaesthesia.

MATERIALS AND METHODS

Study design: Prospective observational study

Study Area: Department of Anaesthesia Indira Gandhi Medical College and Research Institute, Puducherry

Study period: 18 months (June 2023 to November 2024)

Study participants: Patients undergoing elective surgery in any surgical, departments of IGMC&RI, Puducherry.

Inclusion Criteria

- Age greater than 18 years of both sexes
- ASA 1, ASA 2 and ASA 3

Exclusion Criteria

- History of head and neck surgery
- History of radiotherapy
- Presence of any head and neck tumors
- Any pathological condition of the neck

Sample size: Sample size was calculated using OpenEpi version 3, open-source calculator.

Assuming Frequency of outcome as 7.5% Error as 5%, Confidence limit as 5% Confidence interval as 95% Total sample size was 106.

Sampling technique

Convenient sampling

Methodology

The study commenced after obtaining IRC AND IEC approval. It was a prospective observational study done over a period of 18 months in the department of Anaesthesia, IGMCRI. This study was done to find the best ultrasound guided predictor(s) for unanticipated difficult airway.

First 106 patients satisfying inclusion criteria posted and undergoing elective surgery under general anaesthesia were included in the study after obtaining consent.

After obtaining the informed consent, using the Sonosite M turbo USG machine and linear probe (6-15 Hz) and curvilinear probe (2.5-7.5 Hz) imaging was done in supine position with neck in extension.

A linear ultrasound probe was placed at the level of the thyrohyoid membrane, the epiglottis was visible as a hypoechoic curvilinear structure. A bright hyperechoic linear air- mucosal interface would demarcate its posterior border. In this plane thyrohyoid muscles were visible. Identification of the epiglottis will be aided by the protrusion of the tongue or swallowing. Ultrasound measurement of the distance from the skin to epiglottis was performed at median axis.

Figure 1

The two vocal cords with arytenoids appeared as a hyperechoic V-shaped structure. The movement of the vocal cords with breathing was helpful in its identification. Distance from the skin to the apex of the true vocal cords (DVC) was recorded by using linear ultrasound probe.

Conduct of General Anaesthesia

Figure 2

The patient was subjected to general anaesthesia as per the following standard protocol.

Continuous monitoring of ECG, SpO2, non -invasive blood pressure and capnography were done and baseline values were noted. The patient was placed in optimal intubating position..After premedication with inj.midazolam 1mg and Inj glycopyrrolate (10mcg/kg) and Inj fentanyl(2µ/kg) and preoxygenation for 3 min, patient was induced with inj. propofol (2mg/kg) & inj. Vecuronium (100µg/kg). Mask ventilation was then continued with oxygen and isoflurane at 1.2% and ease of mask ventilation was assessed with following criteria and observations were recorded. Mask ventilation was considered as difficult if single anaesthestist is not able to maintain SpO2 of more than 90% with 100 % oxygen without airway adjuvants or required help to maintain bag mask ventilation.

Three minutes after administration of vecuronium, an anaesthetist with at least 3 year of experience intubated the patient. The endotracheal tube position was confirmed by auscultation and capnography and the attempt was considered successful.

A attempt was considered as failed if one of the following criteria was met

1. When the intubating anaesthetist removes the endotracheal tube that was inserted into the mouth for any reason
2. 3 mins had elapsed in an attempt,
3. SpO2 falls less than 92%
4. Oesophageal intubation occurs.

In any of the above situations, the patient was again mask ventilated with 100% of O2 before another attempt was tried. If intubation was unsuccessful after 3 attempts, some other methods of intubation such as fiber- optic bronchoscopy or video laryngoscope was used as per the standard protocol.

Intubation difficulty was assessed and recorded by the intubating anaesthetist with intubation difficulty scale (IDS), on the basis of seven variables associated with difficult intubation. They are as follows:

Intubation Difficulty Scale (IDS)

N1	Number of additional intubation attempts
N2	Number of additional operators
N3	Number of alternative intubation techniques used
N4	Glottic exposure as defined by Cormack and Lehane (grade 1 – N4 = 0; grade 2 – N4= 1; grade 3 – N4 = 2; and grade 4 – N4 = 3)
N5	Lifting force applied during laryngoscopy (N5 = 0 if inconsiderable and N5 = 1 if considerable, as assessed subjectively)
N6	Need to apply external laryngeal pressure to improve glottic visualisation. (N6 = 0 if no external pressure or only the Sellick manoeuvre was applied and N6 = 1 if external laryngeal pressure was used)
N7	Position of the vocal cords at intubation (N7 = 0 if abducted or not visible and N7 = 1 if adducted)

The IDS is the sum of N1 through N7. A score of 0 to 5 indicates no or slight difficulty and >5 indicates moderate to major difficulty.

Patients with the score of ≤ 5 were then grouped as GPN (Normal intubation) and > 5 are grouped as GPI (Difficult intubation) for the purpose of further analysis.

Observations found in both the groups were analysed using following statistical analysis.

Statistical analysis: The data collected were entered into Microsoft excel 2019 and the master chart was created. The master chart was then loaded onto SPSS version 26 for statistical analysis. The variables were of both qualitative and quantitative. Both descriptive and inferential statistics were used in the analysis.The quantitative variables were expressed using mean and standard deviation. The qualitative variables were expressed using frequency and percentages. Medcalc's calculator for diagnostic tool evaluation was used to estimate the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the parameter. 95% confidence interval was estimated for all the parameters.

RESULTS

Table 1: Distribution according to IDS.

IDS	Frequency (n=106)	Percentage (%)
<5 (GPN)	101	95.3
>5(GPD)	5	4.7

Table 2: Distribution according to skin to epiglottis distance (DSE).

Variables		Frequency (n=106)	Percentage (%)
Skin to epiglottis distance (in cm)	1.65-1.84	5	4.7
	1.85-2.04	39	36.8
	2.05-2.24	43	40.6
	2.25-2.44	5	4.7
	>2.44	14	13.2

Table 3: Distribution according to skin to vocal cord distance (DVC).

Variables		Frequency (n=106)	Percentage (%)
Skin to vocal cord distance (in cm)	0.40-0.59	27	25.5
	0.60-0.79	59	55.7
	0.80-0.99	18	17
	>0.99	2	1.9

Table 4: Evaluation of DSE as predictor of difficult intubation.

Statistic	Value	95% CI
Sensitivity	80.00%	28.36% to 99.49%
Specificity	92.08%	84.99% to 96.52%
Positive Predictive Value	33.33%	18.40% to 52.58%
Negative Predictive Value	98.94%	94.15% to 99.81%
Accuracy	91.51%	84.49% to 96.04%

Table 5: Evaluation of DVC as predictor of difficult intubation.

Statistic	Value	95% CI
Sensitivity	80.00%	28.36% to 99.49%
Specificity	64.36%	54.21% to 73.64%
Positive Predictive Value	10.00%	6.25% to 15.62%
Negative Predictive Value	98.48%	91.80% to 99.74%
Accuracy	65.09%	55.22% to 74.10%

DISCUSSION

Encountering unanticipated difficult airway is a nightmare scenario for anyone attempting to secure the airway of a patient. Various parameters like Modified Mallampatti classification, upper lip bite test, hyomental distance, thyromental distance etc. have been used in the past to identify those patients who might present with a difficult airway. Ultrasound measurement of the key spaces in airway anatomy to predict the same has been explored in multiple studies in the past with varying success. The present study was conducted to explore the utility of ultrasound in predicting difficult airway in our study population and also to identify the best predictor.

It was a hospital based prospective observational study carried out among those who had undergone elective surgery under general anaesthesia during the study period. The study included a total of 106 participants. 29.2% were of age 21 to 30 years followed by 17.9% of age groups 13 to 20 years, 31 to 40 years and 41 to 50 years, respectively. 50.9% were males.

57.5% had ASA of 1 and 36.8% had ASA of 2.

In our study we found that distance from skin to epiglottis (DSE) was statistically significant predictor of difficult intubation with a P value of 0.001 and AUC OF 0.850. A distance of more than 2.36 cm was found to be predictor of difficult intubation with the sensitivity of 80% and the specificity of 92%. This suggests DSE as a valid tool for predicting difficult intubation. Fernandez Vaquero MA et al,[3] reported DSE as one of the important USG parameters that could aid in predicting difficult intubation with cut off value of 2.48mm and the sensitivity of 91.30%, specificity was 96.93% and AUC 0.96 (23). Tazdemir O et al,[4] reported DSE to have an AUC of 0.827 which was similar to that of the present study and for difficult intubation they have the cut of value of DSE 18.3 + 3.8.

Kose EOC et al,[5] evaluated the ability of ultrasound parameters to predict difficult airway. Of all the parameters studied, the study concluded DSE of 18.58+3.20 to be the best parameter. The Area under the ROC curve for DSE was 0.847 in the study. The study reported a sensitivity and specificity of 78.6% and 79.4%, respectively for the parameter. Mohammadi SS et al.6 reported a cut off value of 21mm for DSE. The study reported 99% accuracy for DSE with a sensitivity and specificity of 100% and 82%, respectively.

Distance from skin to vocal cords (DVC) was statistically significant with P value of 0.046. The AUC obtained in the present study was 0.687 and a value of 0.7 cm or more indicated the presence of difficult intubation. The sensitivity for DVC was 80% and specificity was 64%. The diagnostic accuracy was estimated to be 65%.). Carsetti A et al,[2] in their review reported that the distance from skin to vocal cords to have an AUC of 0.72 with sensitivity and specificity of 75% and 72%, respectively.

Among the 106 patients studied, difficult intubation was encountered in 5 patients only (IDS of >5). A practical question which can arise is, skin to epiglottis or skin to vocal cord distance, which is able to identify these 5 patients without missing any of them at the same time, without false negative results.

From the above data it is well known that skin to epiglottis distance is the better predictor of difficult airway the skin to vocal cord distance.

Limitations of the study

- The present study was carried out in a single centre. The study population might be homogenous and hence caution should be exercised before applying the study findings to the general population
- As the sample size was relatively small, so the number of patients with difficult airway is relatively less.

- In Intubation Difficulty Scale which is used in this study, parameters like lifting force applied during laryngoscopy and need to apply external laryngeal pressure to improve glottic pressure are subjective
- USG parameters measured are operator dependent, varying with the pressure applied on the skin with the probe and the alignment of the probe with the structures correctly so that measurement are accurate. This would need some degree of training and practice.

CONCLUSION

Skin to epiglottis distance with cutoff value of more than 2.36 cm has better sensitivity, specificity,PPV,NPV, Diagnostic accuracy which is better than skin to vocal distance.So skin to epiglottis distance is the better predictor of difficult airway compared with skin to vocal cord distance.

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