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PREOPERATIVE ULTRASONOGRAPHIC AIRWAY EVALUATION AND CORMACK LEHANE GRADING OF DIRECT LARYNGOSCOPIC VIEW IN UNANTICIPATED DIFFICULT AIRWAY PATIENTS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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ABSTRACT **Background:** Unanticipated difficult intubation remains an important anaesthetic challenge. Conventional airway assessment has limited predictive accuracy, whereas ultrasonography offers a noninvasive approach to evaluating anatomical parameters associated with difficult laryngoscopic visualization. **Objectives:** To evaluate the relationship between preoperative ultrasonographic airway measurements and Cormack–Lehane grading during direct laryngoscopy in patients undergoing elective surgery. **Methodology:** This cross-sectional observational study was conducted at RCSM Government Medical College and CPR Hospital, Kolhapur, from July 2023 to June 2025. Seventy adults aged 18–60 years undergoing elective surgery under general anaesthesia were enrolled. Clinical airway assessment and ultrasonographic measurements, including tongue thickness and skin-to-epiglottis distance, were recorded and compared with intraoperative Cormack–Lehane grading. **Results:** Among 70 participants, 57% were female and 43% were male. The largest age group was 39–48 years (38.5%), and 75.7% had normal body mass index. Easy intubation occurred in 75.7% of patients, whereas 24.3% experienced difficult intubation. Modified Mallampati grade I was observed in 74.3% of participants. Cormack–Lehane grade I accounted for 60%, grade IIA for 11.5%, grade IIB for 12.8%, and grade III for 15.7%; no grade IV cases were reported. Tongue thickness measured 3.5–3.9 cm in 34.2% of patients, while skin-to-epiglottis distance measured 1.30–1.50 cm in 30%. The association between skin-to-epiglottis distance and Cormack–Lehane grading was statistically significant (Pearson chi-square=51.49; p=0.001), supporting its potential role in preoperative airway assessment. **Conclusion:** Preoperative airway ultrasonography demonstrates a significant association between skin-to-epiglottis distance and laryngoscopic grading. It may complement conventional assessment, although larger prospective studies are needed to establish predictive accuracy.

KEYWORDS : Airway Ultrasonography; Difficult Intubation; Cormack–Lehane Classification; Skin-to-epiglottis Distance; Tongue Thickness.

INTRODUCTION

Unexpectedly difficult airways might result in a difficult and unsuccessful tracheal intubation following direct laryngoscopy. This is a dreaded consequence of general anaesthesia because it is linked to significant morbidity and mortality [1]. Difficult laryngoscopy and tracheal intubation still occur in 1.5% to 13% of cases. The substantial interobserver variability and low predictability of widely used screening measures for airway assessment are likely the causes of the inability to anticipate problematic airways [2]. Since then, numerous techniques to address these issues and identify patients who will be challenging to intubate have been developed. The preoperative evaluation of the airway in patients scheduled for surgery is one of such. Numerous standard clinical airway assessment metrics exist, including the modified Mallampati classification [3].

Neck movements, interincisor distance, neck circumference, and hyomental and thyromental distance [4]. Usually, they are used to predict difficult airways. The Modified Cormack-Lehane (CL) classification rates the glottic view as easy or difficult to intubate and is based on direct laryngoscopy, which can only be done under general anaesthesia [5]. Along with clinical techniques and modified Cormack-Lehane classification on direct larygoscopy, ultrasonography has recently emerged as a simple and noninvasive method for airway assessment [6].

Various sonographic techniques have been used to assess the airway, such as ultrasonic measurement of the distance between the skin and epiglottis at the level of the thyrohyoid membrane, soft tissue thickness at the level of the hyoid bone, and vocal cord and hyoid bone visibility [7]. Ultrasonography may be able to anticipate difficult tracheal intubation because it evaluates tongue thickness. There is a greater likelihood of a difficult tracheal intubation if the tongue is thicker (>6.1 cm) [8]. The results showed that the distance between the epidermis and epiglottis at the level of the thyrohyoid membrane offers good predictive outcomes, despite the fact that no useful cutoff for clinical practice was determined[9].

Despite the positive nature of these results, further investigation is necessary before ultrasonographic data can be relied upon for application in routine clinical practice [10]. This investigation was carried out to determine the correlation between the Cormack Lehane grading of the direct laryngoscopic view and the preoperative Ultrasonographic airway assessment in individuals with unexpectedly difficult airways. The present study was conducted to ascertain the relationship of preoperative ultrasonographic airway evaluation and Cormack Lehane grading in unanticipated difficult airway patients.

MATERIAL AND METHODS

The present cross-sectional observational study was conducted at RCSM GMC and CPR Hospital, Kolhapur, for a duration of 2 years, from July 2023 to June 2025. A total of cases with ASA (American Society of Anesthesiologists) grade I, II, III between age 18 and 60 years both males and females scheduled for elective surgery and requiring general anesthesia with direct laryngoscopy and endotracheal intubation in our institution. Patients with Anticipated difficult airway like restricted mouth opening, short neck, preexisting airway malformations or pathology like facial or cervical fractures, maxilla facial abnormalities, cervical tumors or goiter, edentulous might have an unpredictable effect on the USG assessment of the airway, patients with tracheostomy tubes were excluded from the study.

After getting approval from institutional ethical committee, the study was conducted in tertiary care hospital in our institute. Patients were enrolled who were willing to participate in the study after taking written informed consent. Initial training of 15 days in sonographic assement of airway was taken from radiology department in our institution The routine airway assessment including mouth opening, modified Mallampati scoring, thyromental distance, and neck movements, were done by primary anaestheologist during the preanesthetic assessment.

The enrolled patients were undergone sonographic assessment of airway in the preoperative holding area. In the preoperative holding area, with the patient lying supine and active maximal head tilt/chin lift the sonographic assessment was carried out. The high frequency linear probe was placed in the submandibular area in the midline. Without changing the position of the probe, the linear array of the Ultrasound

probe was rotated in the transverse planes from cephalad to caudal, until simultaneous visualization of the epiglottis and posterior part of vocal cords with arytenoids observed on the screen. Thereafter, following measurements were obtained with the transverse US.

The transverse view was used for measuring the skin to hyoid, and the skin to epiglottis distance. The patients were then taken to operating room and the standard general anesthesia procedure was performed as per the discretion of the attending second anaesthesiologist and as per standard of care. Direct laryngoscopy was performed using a Macintosh blade, and the CL grade was noted without external laryngeal manipulation. USG findings were compared with the CL grading on direct laryngoscopy.

Cormack-lehane Classification:
Grade 1: visualization of the entire glottis
Grade 2a: visualization of part of glottis or the arytenoids;
Grade 2b: only the arytenoids or very posterior origin of the cord is seen.
Grade 3: visualization of only the epiglottis;
Grade 4: No glottic structure seen.

The laryngoscopy was classified as easy (CL Grade 1 and 2) or difficult (CL Grade 3 and 4). The trachea was intubated with appropriately sized endotracheal tube and anesthesia was maintained. The number of attempts at intubation, need for alternative difficult airway devices for intubation or inability to secure the airway were noted. Appropriate tests were used as per the requirement.

Statistical Analysis
The data was entered using Microsoft excel sheet and was analysed using Statistical Package for Social Sciences (SPSS) version 26.0 software. Categorical data was presented in form of frequency and proportion. As test of significance for qualitative data inform of frequency and proportion. Chi-square test was used as test of significance for qualitative data. Continuous data was analysed using mean and standard deviation and Mann- Whitney U test A probability of $P < 0.05$ was considered statistically significant.

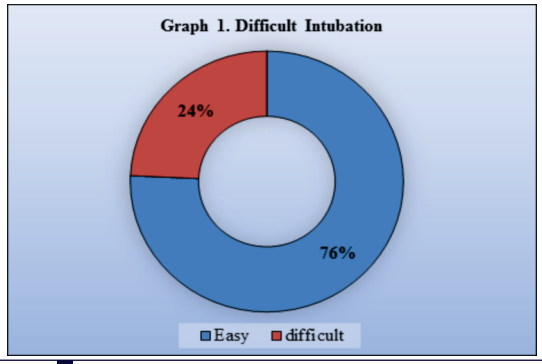
RESULTS:

Table 1. Demographic Profile of the Patients:

Demographic Profile		Frequency	Percent
Age (Years)	18-28	6	8.6
	29-38	15	21.4
	39-48	27	38.5
	49-58	22	31.5
Gender	Female	40	57
	Male	30	43
Body Mass Index	<18.5	1	1.4
	18.6-24.9	53	75.7
	25-29.9	16	22.8
Total		70	100

In the present study there were 70 patients. —The age distribution of the patients in the range of 39-48 years (38.5%) followed by 49-58 years (31.5%), 29-38 years (21.4%) & least 18-28 years (8.6%). Out of 70 patients, 43% male while 57% population is female. 16 patients were overweight. The majority of the patients 76% having normal BMI.

Difficult Intubation
Among study participants, the majority (75.7%) was easy intubation followed by 24.3.% are difficult intubation.



Distribution of ASA Grade
Among study participants, the majority (58.5%) were in grade 1 ASA followed by 30.0% in grade II and 11.5% in grade III respectively.

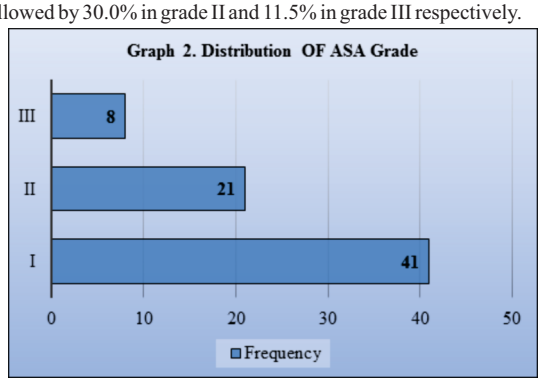


Table 2. Distribution of Mallampatti (MP) Grading

MP grading and CL Classification		Frequency	Percent
Mallampatti Grading	I	52	74.3
	II	12	17.1
	III	6	8.6
	IV	0	0.0
Cormack Lehane (CL) Classification	I	42	60.0
	IIA	8	11.5
	IIB	9	12.8
	III	11	15.7
	IV	0	0.0
Total		70	100.0

Among study participants, the majority were in grade I (74.3%) grading distribution, followed by 17.1% in grade II, 8.6% in grade III respectively. Among study subjects, 60% were in grade I Cormack Lehane grade, followed by 15.7% in grade III, 12.8% in grade II B, 11.5% in grade II A respectively.

Table 3. Tongue Thickness and Distance Between Skin & Epiglottis (DSME) Grading

TT and DESM Grading		No. of Patients	Percentage
Tongue Thickness (TT) (cms)	3.5-3.9	24	34.2
	4.0-4.4	19	27.2
	4.5-4.9	10	14.3
	5.0-5.4	6	8.6
	5.5-5.9	0	0
	6-6.5	11	15.7
DSEM (Distance Between Skin & Epiglottis) Grading	1.30-1.50	21	30.0
	1.51-1.70	15	21.5
	1.71-1.90	13	18.6
	1.91-2.10	10	14.2
	2.11-2.30	06	8.6
	>2.31	05	7.1
Total		70	100.0

Among study subjects 34.2 % were having tongue thickness between 3.5-3.9 cms, followed by 27.2 % were having 4.0-4.4 cms ,14.3% having 4.5-4.9 cms ,8.6 % having 5-5.4 cms,15.7% having 6-6.5cms respectively.

Among study subjects, 30 % were having DSEM between 1.30-1.50 cms , followed by 21.5% were having 1.51-1.70 cms, 18.6% were having 1.71-1.90 cms,14.2 % were having 1.91-2.1 cms,8.6% having 2.11-2.30 cms and 7.1 % having >2.31 cms respectively

Table 4. Association Between Cormack Lahane & DSEM (Distance Between Skin & Epiglottis) Grading

Cormack Lahane	Distance Between Skin & Epiglottis (cm)						Total
	1.30-1.50	1.51-1.70	1.71-1.90	1.91-2.10	2.11-2.30	>2.31	
I	18 (25.7%)	15 (21.4%)	8 (11.4%)	1 (1.4%)	0 (0.0%)	0 (0.0%)	42 (60.4%)
IIA	1 (1.4%)	0 (0.0%)	1 (1.4%)	2 (2.8%)	2 (2.8%)	2 (2.8%)	8 (11.2%)
IIB	0 (0.0%)	0 (0.0%)	1 (1.4%)	5 (7.2%)	0 (0.0%)	3 (4.2%)	9 (12.8%)
III	2 (2.8%)	0 (0.0%)	3 (4.2%)	2 (2.8%)	4 (4.8%)	0 (0.0%)	11 (15.6%)

Total	21 (30.0%)	15 (21.4%)	13 (18.4%)	10 (14.2%)	6 (8.6%)	5 (7.0%)	70 (100%)

Pearson Chi Square-51.49; DF-6 p value-0.001 (Significance)

The association between DSEM (distance between skin & epiglottis) & Cormack Lehane Grading were significant (P< 0.05).

DISCUSSION

The current study shows the relationship between preoperative ultrasound airway assessment and Cormack-Lehane grading in direct laryngoscopic view to predict difficult airways in adult patients.

The current study included seventy patients. Patients between the ages of 39 and 48 made up 38.5% of the total, followed by those between the ages of 49 and 58 (31.5%), 29 and 38 (21.4%), and at least 8.6% (18 and 28). Of the population, 43% are men and 57% are women. According to Yemam D et al. (2022)[11], the majority of study participants (51.8%) were female. The study's participants were between the ages of 18 and 63, with an average age of 39.50 (±12.03) years. Uday Kumar et al. (2023) [12] pointed out that there were 41 females and 59 males in this study. Eighteen patients (18%) were placed in the demanding group, whereas eighty-two patients (82%) were placed in the easy group.

Participants in the study ranged in age from 18 to 70, with 31% being female and 69% being male, according to Reddy et al. (2016) [13]. According to Parameswari et al. (2017) [1], a total of 130 patients were enrolled in the study, including 67 women (51.5%) and 63 males (48.5%). The patients' ages ranged from 18 to 60 years old (mean, 37.38 years; standard deviation, 12.75 years).

Most research participants in our study (51.4%) weigh between 51 and 60 kg, followed by those who weigh between 61 and 70 kg (28.6%), 41 and 50 kg (11.4%), and only 6 people (71 and 80 kg), in that order. According to D. Yeman et al. (2022) [11] the male weighed 61.00 ± 8.78 and the female weighed 58.55 ± 8.45.

In the resent study, Sixty-six percent of the patients had normal BMIs, while 16 patients (22.8%) were overweight. According to D. Yeman et al. (2022) [11] the average BMI was 22.68(±3.00), with a range of 16.50 to 29.38. The ultrasonic measurements primarily show the thickness of the soft tissue in the front neck. The combination of clinical features and ultrasound enhances the sensitivity and specificity of anticipating unexpectedly difficult laryngoscopy.

According to Reddy et al. (2016) [13] the body mass index (BMI) of the study population ranged from 14.2 to 39.0 kg/m^2. According to Uday Kumar et al. (2023) [12] the group that underwent easy laryngoscopy weighed 63.3±10.55 kg on average, while the group that underwent difficult laryngoscopy weighed 69.52±9.03 kg (P < 0.05). The mean BMI for the difficult laryngoscopy group was 26.7±2.70 kg/m2 (p<0.05), whereas the mean BMI for the simple laryngoscopy group was 23.7±3.3 kg/m^2.

In our study, 74.3% of patients are in MPG Grade I, followed by MPG II (17.1%) and MPG III (8.6%), based on the MPG Grade distribution of patients. 15 patients had grade 2 Cormack-Lehane, 7 patients had grade 3 Cormack-Lehane, 8 patients had grade 4 Cormack-Lehane, and 50 patients had grade 1 Cormack-Lehane, according to B. S. Abdelhady et al. (2020) [14]. Reddy et al. (2016)[13] reported that 39% of the patients had CL Grade 1, 47% had CL Grade 2, and 14% had CL Grade 3. There were no CL Grade 4 patients present.

According to Parameswari et al. (2017) [1], 81 patients had a CL view of Grade I (62.3%), 37 patients had a CL view of Grade II (28.5%), 12 patients had a CL view of Grade III (9.2%), and none 60% of the participants in our study were in grade I Cormack Lehane, with 15.7% in grade III, 12.8% in grade II of the patients had a CL view of Grade IV. B, and 11.5% in grade IIA coming next. Grade 1 ASA accounted for the majority of research participants (58.7%), followed by grade II (30.0%) and grade III (11.5).

The following measurements were made on oblique-transverse ultrasound scans of the airway in patients scheduled for tracheal intubation under general anaesthesia in a study by Gupta et al. (2012) [15]; these included (a) the distance between the epiglottis and the midpoint of the vocal folds' separation, (b) the depth of the pre-epiglottic space, and (c) the total amount of time the operator spent creating the final ultrasonic image. These data were compared to the Cormack-Lehane classification obtained during direct laryngoscopy in the operating room. The Cormack-Lehane (CL) grade was found to be adequate with a sensitivity of 67% to 68%.

In research by Sagun et al. (2022) [16] the chance of a difficult intubation was statistically associated with a higher BMI, male gender, and age more than 52 years. The chance of a challenging intubation rises by a factor of 1.02 with each additional year of age. A difficult intubation was 2.11 times more likely to occur in males than in females, and the risk increased by 1.11 times for each unit increase in BMI.

Uday Kumar et al. (2023) [12] observed that before anaesthesia, an ultrasonography airway evaluation was conducted. They concluded that the distance from skin to epiglottis midway (DSEM) and the thickness of anterior neck soft tissue in the transverse view at the level of the thyrohyoid membrane, with a cut-off at 2.03 cm, were positively correlated with difficult laryngoscopy. As part of the examination, the patient's ANS-VC thickness was assessed. Measurements were higher in the difficult laryngoscopy group (1.42 ± 0.28 cm) than in the easy group (0.94 ± 0.18 cm), and a cut-off point of greater than 1.12 was associated with difficult intubation.

B. S. Abdelhady et al. (2020)[14] reported that the DSEM cutoff level for difficult laryngoscopy was >1.85 cm, with a sensitivity of 80% and a specificity of 70.8%**.** Nazir et al's study [17] on 90 Indian patients who had had 19 difficult laryngoscopies found that US-DSE with a cutoff point of 1.77 cm could predict difficult laryngoscopy with a sensitivity of 78.9% and a specificity of 76.3%.

Wu et al. (2014) [18] examined 203 patients in a Chinese Han population who had undergone 28 difficult laryngoscopies. The study found that DSEM had a cut-off point of 1.78 cm for difficult laryngoscopy, with 100.0% sensitivity and 66.3% specificity. However, these results are significantly less than those of the other authors.

In 2015, Mirulnalini et al. [19] examined the effectiveness of ultrasound-guided airway assessment in predicting difficult airway in 150 patients and found that the Distance of Skin to Epiglottis at the level of Thyrohyoid Membrane (DSEM) was statistically highly significant, with a cutoff value of 2.33 cm for the prediction of difficult laryngoscopy. Compared to their 100% sensitivity, this metric displayed a 99.3% sensitivity.

Angel Fernandez Vaquero et al. (2022)[20] carried out a prospective observational study on preoperative airway assessment in sniffing posture utilising USG on parameters including DSHB, DSAC, and DSEM. The study discovered that DSEM, with a minimal thickness of cut off at 2.70 ± 0.19, sensitivity of 91.3%, and specificity of 96.9%, is the most dependable measure for challenging laryngoscopy.

Shi et al. (2017) [21] found that DSEM's cutoff point for the difficult laryngoscopy group was 2.36 cm with a specificity of 96.43% and a sensitivity of 60%, compared to Wu et al's [18] cutoff point of 1.78 cm in a study involving 71 Chinese patients.

Adhikari et al's (2011) study[22] included 51 African American patients. Six patients in all underwent challenging laryngoscopies. The US-DSE cutoff point for challenging laryngoscopy was 2.8 cm. Falcetta's study included 301 adult Italian patients, of whom 28 had difficult laryngoscopies. The study found that US-DSE had a 91% specificity, 82% sensitivity, and a cut-off value of 2.54 cm.

Pinto et al's [23] study was conducted on a Portuguese population and included 74 adult patients with 17 difficult laryngoscopies. According to Pinto et al.[24], a US-DSE of 2.75 cm was a good cutoff point for difficult laryngoscopy because it had a sensitivity of 64.7% and a specificity of 77.1%.

A study by Martínez-Garcia et al.(2020)[24] included 16 difficult laryngoscopies (32%) on 50 Spanish patients. DSE ≥ 3 cm may predict with 56.3% sensitivity and 88.2% specificity, they discovered. Parameswari's [1] findings, however, contained other contradictions that set them apart from all other authors, including Mirunalini et al[19] & Nazir et al[17], whose research was also carried out in India. Twelve of the 130 Indian patients in a study by Parameswari et al.[1] underwent difficult laryngoscopies. The study found that patients with an 18 mm skin-to-epitglottis distance were predicted to be easy with a 63.6% specificity and a 75% sensitivity.

Of the participants in our study, 30% had DSEMs between 1.30 and 1.50 cm, followed by 21.5% with 1.51 to 1.70 cm, 18.6% with 1.71 to 1.90 cm, 14.2% with 1.91 to 2.1 cm, 8.6% with 2.11-2.30 cm, and 7.1% with >2.31 cm, in that order. According to our research, patients who have a skin-to-epitglottis distance of more than 1.9 cm at the level of the thyroid membrane have trouble intubating, whereas those who have a distance of 1.5 to 1.9 cm have no trouble.

Of the study participants, 34.2% had tongue thicknesses between 3.5 and 3.9 cm, followed by 27.2% with 4.0-4.4 cm, 14.3% with 4.5-4.9 cm, 8.6% with 5-5.4 cm, and 15.7% with 6-6.5 cm. Our research revealed that tongue thicknesses greater than 6 cm made intubation difficult, whereas those less than 6 cm made it simple.

CONCLUSION

The present study demonstrates a significant association between preoperative ultrasonographic airway assessment and Cormack–Lehane grading during direct laryngoscopy. Among 70 patients, 24.3% experience difficult intubation, while distance from skin to epiglottis shows a statistically significant association with laryngoscopic grade (p=0.001). Increased tongue thickness also appears to be associated with difficult intubation.

These findings support ultrasonography as a useful adjunct to conventional airway assessment, potentially improving preoperative risk stratification and preparedness for unexpected airway management difficulties. Routine incorporation of airway ultrasonography alongside clinical assessment, supported by standardized measurements, operator training, and larger prospective validation studies, is recommended.

REFERENCES

1. Parameswari A, Govind M, Vakamudi M (2017) Correlation between preoperative ultrasonographic airway assessment and laryngoscopic view in adult patients: a prospective study. J Anaesthesiol Clin Pharmacol 33:353–358
2. Khan ZH, Kashfi A, Ebrahimkhani E. A comparison of the upper lip bite test (a simple new technique) with modified mallampati classification in predicting difficulty in endotracheal intubation: A prospective blinded study. Anesth Analg 2003; 96: 595-9.
3. Mallampati SR. Clinical sign to predict difficult tracheal intubation (hypothesis). Can Anaesth Soc J 1983;30:316- 7.
4. Karkouti K, Rose DK, Wigglesworth D, Cohen MM. Predicting difficult intubation: A multivariable analysis. Can J Anaesth 2000;47:730- 9
5. Khan ZH, Mohammadi M, Rasouli MR, Farrokhnia F, Khan RH. The diagnostic value of the upper lip bite test combined with sternomental distance, thyromental distance, and interincisor distance for prediction of easy laryngoscopy and intubation: A prospective study. Anesth Analg 2009;109:822- 4
6. Baker P: Assessment Before Airway Management. Anesthesiol Clin 33:257-278, 2015.
7. Singh M, Chin KJ, Chan VW, et al.: Use of sonography for airway assessment: an observational study. J Ultrasound Med 29:79-85, 2011
8. Ezri T, Gewurtz G, Sessler DI, et al.: Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia 58:1111-1114, 2003
9. Adhikari S, Zeger W, Schmier C, et al.: Pilot study to determine the utility of point-ofcare ultrasound in the assessment of difficult laryngoscopy. Acad Emerg Med 18:754-758, 2011
10. Wu J, Dong J, Ding Y, et al.: Role of anterior neck soft tisse quantifications by ultrasound in predicting difficult laryngoscopy. MedSci Monit 20:2343-2350, 2014
11. Yemam D, Melese E, Ashebir Z. Comparison of modified mallampati classification with Cormack and Lehane grading in predicting difficult laryngoscopy among elective surgical patients who took general anesthesia in Werabie comprehensive specialized hospital - Cross sectional study. Ethiopia, 2021. Ann Med Surg (Lond). 2022 Jun 24;79:103912.
12. Udayakumar GS, Priya L, Narayanan V. Comparison of Ultrasound Parameters and Clinical Parameters in Airway Assessment for Prediction of Difficult Laryngoscopy and Intubation: An Observational Study. Cureus. 2023 Jul 5;15(7):e41392.
13. Reddy Preethi, PunethaPankaj, ChalamKolli S. Ultrasonography-A viable tool for airway assessment. Indian J Anaesth. 201660(11): 807-813.
14. Abdelhady BS, Elrabiey MA, Abd Elrahman AH, Mohamed EE (2020). Ultrasonography versus conventional methods (Mallampati score and thyromental distance) for prediction of difficult airway in adult patients. Egyptian Journal of Anaesthesia, 36(1), 83–89.
15. Gupta D, SrirajaKalidindi A, Ittiara B, Apple L, Toshniwal G, Haber H. Ultrasonographic modification of Cormack Lehane classification for pre- anaesthetic airway assessment. Middle East J Anaesthesiol. 2012
16. Sagün A, Ozdemir L, Melikogullari SB. The assessment of risk factors associated with difficult intubation as endocrine, musculoskeletal diseases and intraoral cavity mass: A nested case control study. Ulus Travma Acil Cerrahi Derg. 2022 Sep 1;28(9):1270-6.
17. Nazir I, Mehta N: A comparative correlation of pre-anesthetic airway assessment using ultrasound with Cormack Lehane classification of direct laryngoscopy. IOSR J Dent Med Sci. 2018, 17:43-51.
18. Wu J, Dong J, Ding Y, Zheng J. (2014). Role of Anterior Neck Soft Tissue Quantifications by Ultrasound in Predicting Difficult Laryngoscopy. Medical Science Monitor: International Medical Journal of Experimental and Clinical Research, 20, 2343- 2350.
19. Mirulnalini G. A Prospective Observational Study to Determine the Usefulness of Ultrasound Guided Airway Assessment Preoperatively in Predicting Difficult Airway. 2015.
20. Fernandez-Vaquero MA, Charco-Mora P, Garcia-Aroca MA, Greif R. Preoperative airway ultrasound assessment in the sniffing position: a prospective observational study. Braz J Anesthesiol. 2022 Jul 30:S0104- 0014(22)00088-4.
21. Shi D, Ni H, He G, et al. Value of ultrasonic measurement of distance from skin to epiglottis for predicting the difficult airway. J Shanghai Jiaotong Univ (Med Sci). 2017;37(3):373–376.
22. Adhikari S, Zeger W, Schmier C, Gun T, Craven A, Frrokaj I, et al: Pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy. AcadEmerg Med. 2011 Jul; 18 (7): 754-8.
23. Pinto J, Cordeiro L, Pereira C, Gama R, Fernandes HL, Assunção J. Predicting difficult laryngoscopy using ultrasound measurement of distance from skin to epiglottis. Journal of Critical Care. 2016;33:26–31.
24. Martínez-García A, Guerrero-Orriach JL, Pino-Gálvez MA. Ultrasonography for predicting a difficult laryngoscopy. Getting closer. Journal of Clinical Monitoring and Computing. 2021 Apr;35(2):269–277