Utility of ultrasonography for prediction of difficult airway and assessment of dynamic airway changes

Shehla Bashir[1], Suhail Sidiq[2], Bashir Ahmad Dar[3], Majid Jehangir[4], Razia Hamid[5], Feroze Shaheen[6], Abdul Waheed Mir[7]

[1,5]Resident, [3]Professor, [4]Assistant Professor, Department of Anesthesiology, [2]Associate Professor, [7]Additional Professor, Critical Care Medicine, [6]Professor, Department of Radiodiagnosis, Sher-Kashmir-Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India

Submission: 04-11-2023 Revision: 28-01-2024 Publication: 01-03-2024

ABSTRACT

Background: Several clinical tools are used for preoperative airway assessment. Ultrasound is an emerging tool in anesthesia, and its role in the upper airway needs to be explored. **Aims and Objectives:** We aimed to assess the role of airway ultrasound in predicting difficult laryngoscopy and airway changes following induction of anesthesia. **Materials and Methods:** Clinical airway assessment was performed with a modified Mallampati score in 100 elective surgical patients. Ultrasound variables in pre- and post-induction of anesthesia were: distance between the skin and vocal cords at the hyoid bone (DSVC hb), distance from the skin to the thyroid isthmus, distance from the skin to the tracheal ring at suprasternal notch level, and distance between the skin and the cricothyroid (DSCM). Cormack–Lehane (CL) grades 3b and 4 were classified as having a DL. Association of clinical, ultrasonography (USG) indicators and CL grading was correlated. Dynamic changes in anterior neck tissues following induction of anesthesia were also measured. **Results:** Pre-induction USG variables were significantly higher in the DL group compared to the NDL group ($P<0.05$), except DSCM. Post-induction all USG parameters were significantly higher in the DL group. Among USG variables, DSVC hb and DTSI had the highest AUCs of 0.801 and 0.772, respectively. DSVC hb had a sensitivity of 76% and a specificity of 100% for DL. DTSI had a sensitivity of 92% and a specificity of 72%. There was a significant increase in depth after anesthetic induction of all USG parameters except DSCM. **Conclusions:** Ultrasound of anterior airway tissues can be considered for prediction of DL and allows dynamic airway assessment.

Key words: Difficult laryngoscopy; Anterior neck tissue, Ultrasound

Access this article online

Website:

http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v15i3.59747

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

The incidence of difficult airways varies from 5% to 22%.[1] Ninety-four percent of patients with difficult mask ventilation and 93% of cases with difficult intubation are unanticipated. Difficult intubation during laryngoscopy may potentially cause a life-threatening scenario.[2] Predicting a “difficult airway” is not easy, as many dynamic structures and functional units are involved in the pathogenesis of a difficult airway, and it also depends on the operator’s experience.[2,3] Clinicians may be better prepared if a difficult airway is diagnosed pre-operatively.[3,4] A number of clinical airway assessment tools have been established for anticipating difficult intubation, including the modified Mallampati classification, thyromental distance, hyomental distance, neck circumference, and inter-incisor distance. However, the utility of these clinical screening tests is limited by their low sensitivity and high variability.[5] Radiological tools like ultrasonography (USG) or computed tomography (CT) have also been used to evaluate the anatomical structures of the airway to address an unanticipated difficult airway. The utility of CT is limited as

Address for Correspondence:
Dr. Bashir Ahmad Dar, Department of Anesthesiology, Sher-Kashmir-Institute of Medical Sciences, Soura, Srinagar - 190 011, Jammu and Kashmir, India. **Mobile:** +91-9622457578. **E-mail:** drbdar1@gmail.com

it needs substantial equipment, and real-time observation is not practical.[6] Point-of-care ultrasound is a widely available, non-invasive tool with no radiation and is available in operating areas. Point-of-care ultrasound has been used for the diagnosis of obstructive sleep apnea, vascular access, and guidance of airway nerve blocks.[7,8] Recently, ultrasound has also been used for the evaluation of airway anatomy. Its potential use for real-time visualization of collapsibility and other dynamic changes in the airway in response to positioning, anesthetic induction, and the administration of sedative agents and muscle relaxants opens a new frontier for perioperative airway assessment and deserves to be explored further. In this study, we aimed to understand the US ability to predict difficult laryngoscopy and dynamic airway changes following induction of anesthesia, evaluating the possible role of this tool in clinical practice.

Aims and objectives

Aim of the study was to assess the role of airway ultrasound in predicting difficult laryngoscopy and airway changes following induction of anesthesia.

MATERIALS AND METHODS

This prospective observational double blind study for prediction and assessment of difficult airway and dynamic airway changes after induction of anesthesia was conducted in the Department of Anesthesiology at a tertiary care center in North India over a period of 2 years. After approval by the institutional ethical committee (ref no. 122/ETH/GMC/ICMR), 100 patients were recruited with more than 80% power of study at a 5% significance level. The subjects were recruited from surgical wards, and written informed consent was obtained during the preoperative visit. Patients aged 18 to 65 who were scheduled for elective surgery under general anesthesia in the operating room were screened for eligibility.

Inclusion criteria

1. Adult patients underwent elective surgery requiring general anesthesia.
2. American Society of Anaesthesiologists (ASA) status I, II.
3. Patients with ages >18 years and <65 years.
4. Patients with heights of 150–180 cm.

Exclusion criteria

1. Patients are not satisfying the inclusion criteria.
2. Patients necessitate rapid sequence induction.
3. Patients with predicted difficult airways.
4. Pregnant patients.
5. Patients who were unconscious or severely ill.
6. Morbidly obese patients.
7. Participation refusal.

A medical history was obtained, and baseline patient characteristics, including age, gender, height, weight, body mass index (BMI), and ASA physical status, were recorded. Airway examination for anomalies of the mouth and tongue, temporomandibular joint pathology, facial anomalies, and pathology of the nose and palate. Preoperative screening for difficult airways was done by the Mallampatti score.

Sonographic airway measurements were performed before and after anesthetic induction. The thicknesses of the anterior neck soft tissues were measured with a portable ultrasound machine (ESAOTE S.p.A. via E Melen 77, Genova, Italy, 2020). A 6–13 MHz frequency linear/curvilinear ultrasound transducer was used for ultrasound scanning. Patients were explained about the USG procedure and positioned in supine with the head in a neutral position. USG was performed with the probe placed in the transverse axis, and a craniocaudal sagittal scan in the submental region of the neck. The distances were measured at the following levels with normal and extended neck positions in the median axis.

- Level 1: Distance from skin to vocal cord thickness at hyoid bone level (DSVC hb)
- Level 2: Distance from skin to thyroid isthmus (DSTI)
- Level 3: Distance from skin to tracheal ring thickness at suprasternal notch level (DSTR sn)
- Level 4: Distance from skin to cricothyroid membrane level (DSCM)

Measurement sites used during the pre-induction period were marked to allow easier positioning of the probe at the same site after induction for subsequent measurements. The amount of soft tissue in each zone was calculated by the average of soft tissues in millimeters obtained along the central axis of the neck. The induction was performed as per standard anesthetic practice. A repeat measurement of ultrasound parameters was done after anesthetic induction. Laryngoscopy was performed by an experienced anesthesiologist who was blinded by pre-induction ultrasonographic findings. A modified Cormack–Lehane classification system was used to grade the ease of laryngoscopy. CL grades 1 or 2a, grades 2b or 3a, and grades 3b or 4 were designated as easy, restricted, and difficult laryngoscopies, respectively.

- Entire vocal cord visualized – Grade I
- Posterior part of vocal cords seen – Grade IIa
- Arytenoids are only seen – Grade IIb
- Epiglottis only seen (lift-able) – Grade IIIa

- Epiglottis only seen (adherent) – Grade IIIb
- No glottis structure was seen – Grade IV.

Primary outcomes

The primary outcome was the association of pre- and post-induction ultrasonographic airway measurements with difficult airways (CL IIIb and IV).

Secondary outcomes

Dynamic upper airway changes after induction of anesthesia.

Statistical methods

The recorded data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as mean±SD, and categorical variables were summarized as frequencies and percentages. The student's independent t-test or Mann–Whitney U-test, whichever was feasible, was employed for comparing continuous variables. The chi-square test or Fisher's exact test, whichever was appropriate, was applied for comparing categorical variables. For the optimal cutoff of USG variables, receiver operating characteristic analysis was performed. Pearson correlation was employed to determine the correlation coefficient. $P<0.05$ was considered statistically significant.

RESULTS

A total of 123 patients were checked for eligibility. 17 patients did not meet the inclusion criteria; 3 patients USG post-induction could not be done; 1 patient did not consent to the study; and 2 patients were postponed because of surgical reasons. 56 patients were male, and the rest, 44, were female. A pre-operative clinical assessment of the airway was done using the Mallampatti score (MPS).

Difficult laryngoscopy (CL grade ≥3b) was found in 25 patients, and 75 patients had non-difficult laryngoscopy (CL ≤3a). Patient characteristics are shown in Table 1.

There was a significant increase in the depth of DSVC Hb, DTSI, and DSTRsn post-induction of anesthesia. However, there was no difference in DSCM after the induction of anesthesia Table 2.

On comparison of USG variables at pre-induction, there was a significant difference between difficult and non-difficult laryngoscopy in DSVC, DTSI, and DSTRsn. There was no difference between the difficult and non-difficult groups in DSCM at pre-induction. At post-induction of anesthesia, there was a significant difference in all USG variables in the difficult and non-difficult laryngoscopy groups (Table 3).

Table 1: Demographics of the groups

Group	DL group (n=25)	Non DL group (n=75)	P value
Age (years)	49.6±13.16	46.1±12.55	0.236
Gender			
Male (%)	20 (80%)	24 (32%)	
Female (%)	5 (20%)	51 (68%)	0.001*
ASA			
ASA I (%)	12 (48%)	59 (78.7%)	
ASA II (%)	13 (52%)	16 (21.3%)	0.003*
BMI (kg/m^2)	29.59±2.02	24.66±2.55	0.001*
MPS			
Grade 1	8 (32.0%)	38 (50.7%)	0.002*
Grade 2	9 (36.0%)	34 (45.3%)	
Grade 3	4 (16.0%)	2 (2.7%)	
Grade 4	4 (16.0%)	1 (1.3%)	
CL Grade			
Grade 1	0 (0%)	42 (56%)	0.001*
Grade 2	0 (0%)	23 (30.6%)	
Grade 3a	0 (0%)	10 (13.3%)	
Grade 3b	14 (56.0%)	0	
Grade 4	11 (44.0%)	0	

DL: Difficult laryngoscopy, NDL: Non-difficult laryngoscopy, MPS: Mallampatti scoring, CL: Cormack Lehane grading, ASA: American Society of Anesthesiologists, BMI: Body mass index

Table 2: Pre and post induction values of USG in two groups

Variable	Pre induction	Post induction	P value
DSVC Hb	1.23±0.09	1.24±0.09	<0.001*
DSTI	1.26±0.09	1.28±0.09	<0.001*
DSTRsn	1.33±0.49	1.36±0.46	0.018*
DSCM	1.44±0.31	1.44±0.30	0.822

DSVC Hb: Distance from skin to vocal cords at hyoid bone, DSTI: Distance from skin to thyroid isthmus, DSTRsn: Distance from skin to tracheal rings at supra sternal notch, DSCM: Distance from skin to cricothyroid membrane, USG: Ultrasonography

Table 3: Pre and post induction USG variables in two groups

USG variable	DL	NDL	P value
Pre induction			
DSVC Hb	1.32±0.145	1.21±0.053	<0.001*
DSTI	1.35±0.143	1.24±0.041	<0.001
DSTRsn	1.54±0.680	1.22±0.359	0.004*
DSCM	1.52±0.330	1.41±0.280	0.133
Post induction			
DSVC Hb	1.33±0.146	1.22±0.051	<0.001*
DSTI	1.36±0.140	1.26±0.041	<0.001*
DSTRsn	1.58±0.699	1.22±0.359	0.02*
DSCM	1.55±0.351	1.41±0.280	0.045*

DSVC Hb: Distance from skin to vocal cords at hyoid bone, DSTI: Distance from skin to thyroid isthmus, DSTRsn: Distance from skin to tracheal rings at supra sternal notch, DSCM: Distance from skin to cricothyroid membrane

The AUC was the maximum for DVSC hb (0.801), with a sensitivity of 76% and a specificity of 100% and a cut-off value >1.35 cm (Table 4). DTSI had a sensitivity of 92% and a specificity of 72%, with a cut-off value of >1.31 cm.

Table 4: ROC analysis with cut off, sensitivity, specificity, positive predictive value and negative predictive value of MPS and ultrasound values for predicting difficult laryngoscopy

Variable	AUC (95% CI)	Cut off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
MPS >3	0.703 (0.594–0.891)	3	48	86.7	54.5	83.8	84
DSVC hb	0.801 (0.709–0.874)	1.35	76	100	100	92.6	94
DSTI	0.772 (0.677–0.849)	1.31	92	72	98.7	91.4	92
DSTRsn	0.689 (0.584–0.778)	1.50	68	88	65.4	89.2	83
DSCM	0.632 (0.531–0.727)	1.35	60	82.7	53.6	86.1	77

DSVC hb: Distance from skin to vocal cords at hyoid bone, DSTI: Distance from skin to thyroid isthmus, DSTRsn: Distance from skin to tracheal rings at supra sternal notch, DSCM: Distance from skin to cricothyoid membrane, ROC: Receiver operating characteristic, AUC: Area under the curve, CI: Confidence interval, MPS: Mallampatti score, PPV: Positive predictive value, NPV: Negative predictive value

Table 5: Correlation coefficient of clinical parameters and USG variables in predicting difficult laryngoscopy

Variable	Correlation coefficient	P value
BMI (Kg/m^2)	0.207	0.039*
MPS	0.417	<0.001*
Pre induction		
DSVC hb	0.544	<0.001*
DTSI	0.625	<0.001*
DSTR sn	0.362	<0.001*
DSCM	0.162	0.107
Post induction		
DSVC hb	0.567	<0.001*
DTSI	0.627	<0.001*
DTSRsn	0.393	<0.001*
DSCM	0.205	0.041*

BMI: Body mass index, MPS: Mallampatti score, DSVC hb: Distance from skin to vocal cords at hyoid bone, DSTI: Distance from skin to thyroid isthmus, DSTRsn: Distance from skin to tracheal rings at supra sternal notch, DSCM: Distance from skin to cricothyoid membrane, USG: Ultrasonography

DSVC hb and DTSI had a moderately positive correlation with difficult laryngoscopy. This correlation was present in both pre-induction and post-induction of anesthesia. Also, DSTR sn and DSCM had lower validity than MPS in predicting difficult airways (Table 5).

DISCUSSION

Several clinical tests are recommended for airway assessment to predict difficult airways.[9] Routine airway clinical assessment is limited to external suprahyoid evaluation (mouth opening, interincisor distance, hyomental, thyromental, and sternomental distances). The current guidelines for pre-procedural assessment recommend using a combination of validated clinical tests to predict difficult airways, as no single clinical test is sufficient by itself.[9] Better tools to predict a possible difficult airway and laryngoscopy prior to the patient transferring to the operating room can spare both the anesthesiologist and patient from the stress associated with the traumatic encounter of an unexpectedly difficult intubation. USG is a relatively quick procedure that takes only a few minutes to perform. This study examined USG as a tool for predicting difficult laryngoscopy and also studied dynamic changes in the upper airway after anesthetic induction.

The incidence of difficult laryngoscopy in our study was 25%, which is higher than in other studies. Although laryngoscopy was performed by an experienced anesthesiologist, Krishna et al., reported an incidence of 8.5% DL in the Indian population.[10] This difference in incidence of DL could probably be due to a different ethnic population.

The majority of DL patients were male (80%). The difficult laryngoscopy group had a significantly higher BMI than the non-DL group.

In our study, MPS had a fairly good accuracy in predicting difficult laryngoscopy with an AUC of 0.70, a sensitivity of 48%, and a specificity of 86.7%. The original Mallampati test identified difficult intubations with a high degree of accuracy, with a sensitivity of 50% and a specificity of 100%. However, subsequent larger studies have shown only modest degrees of accuracy using the original and modified versions of the test.[11] The accuracy of the Mallampati test may also vary with ethnicity, gender, and pregnancy.[12]

In our study, DSVC hb and DTSI have good sensitivity and specificity as compared to previous studies, which showed limited sensitivity and specificity. The sensitivity and specificity of DSVC hb were higher than those of MPS in our study. Yadav et al., found sensitivity and specificity of 68% and 73% for the skin to hyoid bone distance in a neutral position, and it was higher than clinical parameters.[13]

Wu et al., found a strong positive linear correlation (r=0.74) between the distance of the skin to the thyrohyoid membrane (DSEM) and the distance of the skin to the hyoid bone (DSHB) for difficult airways. DSEM and DSHB were greater in the DL group (P<0.0001). The AUC of these USG variables was >0.9, indicating they are good parameters for predicting difficult laryngoscopy.[14]

Parameswari et al., in their study on 130 patients, found DSHB had lower sensitivity (58.3%) and specificity (56.8%) than DSE sensitivity (75%), specificity (63.6%) in predicting difficult airways. In our study, DSVC hb had good sensitivity (76%) and specificity (100%) for difficult airways. Parameswari et al., found skin to epiglottis most sensitive and specific in predicting difficult airways.[15]

Sara et al., in a systemic review and meta-analysis concluded that the distance from the skin to the hyoid bone using ultrasound was significant in predicting a difficult laryngoscopy. This was in concordance with our findings; however, meta-analysis did not find any significance of skin to thyroid isthmus in predicting difficult laryngoscopy. Its overall effect was not significant (P=0.06).[16]

Wu et al.,[14] concluded that a skin-to-hyoid bone distance greater than 1.28 cm predicts a difficult laryngoscopy. Our cutoff value for DSVC hb for DL was 1.35 cm. Our cutoff values of anterior neck tissues were different from other studies, which probably could be due to a different population sample.[17]

Wang et al., studied pre- and post-induction anesthesia airway changes and concluded that pre-induction USG variables were better predictors of DL. We found similar results for pre- and post-induction USG variables in predicting DL.[18]

Many studies have assessed tongue volume in predicting DL. We did not assess tongue volume with USG or its association with DL. Our study only included the thickness of the anterior neck tissues. Although volume of tongue had reasonable sensitivity and specificity in predicting DL, it was not as predictive as anterior neck tissue.[15]

Wojtczak et al., performed a study on tongue size and difficult airways and concluded that tongue volume played no role in predicting difficult airways.[19]

We observed pre-airway tissue structures in neutral and sniffing positions. There is limited data available on changes in the upper airway following anesthesia. There was a significant increase in the depth of all USG parameters except DSCM. We found a tendency for the upper airway to collapse after muscle relaxation, which was consistent with the previous study.[20] These studies have observed genioglossus EMG and airway closing pressure to identify airway collapsibility. Instead, we used USG for identifying airway changes. Wang X also observed dynamic airway changes after anesthetic induction using USG. They also found a propensity for upper airway collapsibility after anesthesia induction.[18]

Inhibition of central drive after anesthesia could lead to relaxation of pharyngeal tone, leading to collapsibility of the upper airway.[21]

Inspiratory and respiratory pump muscle inhibition after anesthesia could also contribute to observed changes in upper airway collapsibility. Identification of upper airway collapsibility after anesthetic induction may be crucial to avoid tongue falls in outdoor anesthesia for procedures such as upper gastrointestinal endoscopy and endoscopic retrograde cholangiopancreatography.

Limitations of the study

We excluded morbidly obese patients (obviously difficult airways); the use of ultrasound in this group of patients needs to be evaluated. We only studied MPS in clinical screening of DL; we did not test other clinical predictors of DL. This was a single-center observational study of the Kashmiri population; extrapolation to other ethnic populations needs further evaluation. This study included patients undergoing elective surgeries and the role of USG in time-critical scenarios like emergencies and intensive care unit needs evaluation. Optimum cut-off values need future research and validation. The difference between pre- and post-induction USG values is a few mm, so any application of excess pressure to anterior neck tissues may result in varied results.

CONCLUSION

We found good validity with greater sensitivity and specificity for DSVC and DTSI compared to MPS. We did not find much significance in other USG variables. Both pre-induction and post-induction DSVC and DTSI can be used with similar predictability for DL. USG can be combined with clinical assessment to predict difficult airways. Our study also reaffirmed the airway collapsibility after anesthetic induction.

ACKNOWLEDGEMENT

None.

REFERENCES

1. Vannucci A and Cavallone LF. Bedside predictors of difficult intubation: A systematic review. Minerva Anestesiol. 2016;82(1):69-83.
2. Sorbello M, Afshari A and De Hert S. Device or target? A paradigm shift in airway management: Implications for guidelines, clinical practice and teaching. Eur J Anaesthesiol. 2018;35(11):811-814. https://doi.org/10.1097/EJA.0000000000000893
3. Cook TM, Woodall N, Frerk C and Fourth National Audit

Project. 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):617-631.
https://doi.org/10.1093/bja/aer058

4. Cormack RS and Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984;39(11):1105-1111.
5. Cook TM and MacDougall-Davis SR. Complications and failure of airway management. Br J Anaesth. 2012;109(1):i68-i85.
https://doi.org/10.1093/bja/aes393
6. Hillman DR, Platt PR and Eastwood PR. The upper airway during anaesthesia. Br J Anaesth. 2003;91(1):31-39.
https://doi.org/10.1093/bja/aeg126
7. Heidegger T. Management of the difficult airway. N Engl J Med. 2021;384(19):1836-1847.
https://doi.org/10.1056/NEJMra1916801
8. Frerk C, Mitchell VS, McNarry AF, Mendonca C, Bhagrath R, Patel A, et al. Difficult airway society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015;115(6):827-848.
https://doi.org/10.1093/bja/aev371
9. Rosenblatt W, Ianus AI, Sukhupragarn W, Fickenscher A and Sasaki C. Preoperative endoscopic airway examination (PEAE) provides superior airway information and may reduce the use of unnecessary awake intubation. Anesth Analg. 2011;112(3):602-607.
https://doi.org/10.1213/ANE.0b013e3181fdfc1c
10. Krishna HM, Agarwal M, Dali JS, Rampal P and Dua CK. Prediction of difficult laryngoscopy in Indian population: Role of patient's height to thyromental distance. J Anaesth Clin Pharmacol. 2005;1:257-260.
11. Lee A, Fan LT, Gin T, Karmakar MK and 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):1867-1878.
https://doi.org/10.1213/01.ane.0000217211.12232.55
12. Nørskov AK, Rosenstock CV, Wetterslev J, Astrup G, Afshari A and Lundstrøm LH. Diagnostic accuracy of anaesthesiologists' prediction of difficult airway management in daily clinical practice: A cohort study of 188 064 patients registered in the Danish anaesthesia database. Anaesthesia. 2015;70(3):272-281.
https://doi.org/10.1111/anae.12955
13. Yadav NK, Rudingwa P, Mishra SK and Pannerselvam S. Ultrasound measurement of anterior neck soft tissue and tongue thickness to predict difficult laryngoscopy-an observational analytical study. Indian J Anaesth. 2019;63(8):629-634.
https://doi.org/10.4103/ija.IJA_270_19
14. Wu J, Dong J, Ding Y and Zheng J. Role of anterior neck soft tissue quantifications by ultrasound in predicting difficult laryngoscopy. Med Sci Monit. 2014;20:2343-2350.
https://doi.org/10.12659/MSM.891037
15. Parameswari A, Govind M and Vakamudi M. Correlation between preoperative ultrasonographic airway assessment and laryngoscopic view in adult patients: A prospective study. J Anaesthesiol Clin Pharmacol. 2017;33(3):353-358.
https://doi.org/10.4103/joacp.JOACP_166_17
16. Gomes SH, Simões AM, Nunes AM, Pereira MV, Teoh WH, Costa PS, et al. Useful ultrasonographic parameters to predict difficult laryngoscopy and difficult tracheal intubation-a systematic review and meta-analysis. Front Med (Lausanne). 2021;8:671658.
https://doi.org/10.3389/fmed.2021.671658
17. Gupta D, Srirajakalidindi A, Ittiara B, Apple L, Toshniwal G and Haber H. Ultrasonographic modification of cormack lehane classification for pre-anesthetic airway assessment. Middle East J Anaesthesiol. 2012;21(6):835-842.
18. Wang X, Wang Y, Zheng ZW, Liu YR and Ma WH. Ultrasound measurements for evaluation of changes in upper airway during anaesthesia induction and prediction difficult laryngoscopy: A prospective observational study. Sci Rep. 2022;12(1):18564.
https://doi.org/10.1038/s41598-022-21695-2
19. Wojtczak JA. Submandibular sonography: Assessment of hyomental distances and ratio, tongue size, and floor of the mouth musculature using portable sonography. J Ultrasound Med. 2012;31(4):523-528.
https://doi.org/10.7863/jum.2012.31.4.523
20. Mendonca C, Ungureanu N, Nowicka A and Kumar P. A randomised clinical trial comparing the 'sniffing' and neutral position using channelled (KingVision®) and non-channelled (C-MAC®) videolaryngoscopes. Anaesthesia. 2018;73(7):847-855.
https://doi.org/10.1111/anae.14289
21. Eastwood PR, Platt PR, Shepherd K, Maddison K and Hillman DR. Collapsibility of the upper airway at different concentrations of propofol anesthesia. Anesthesiology. 2005;103(3):470-477.
https://doi.org/10.1097/00000542-200509000-00007

Authors Contribution:
SB- Implemented study protocol, data collection, prepared draft of manuscript, **SS-** Manuscript preparation, submission of article, **BAD-** Concept, design, intellectual content, **MJ-** Data analysis, editing**. RH-** Editing, literature search. **AWM-** Statistical analysis.

Work attributed to:
Sher i Kashmir Institute of Medical Sciences Soura Srinagar, Srinagar, Jammu and Kashmir, India.

Orcid ID:
Shehla Bashir - https://orcid.org/0009-0001-9714-3782
Suhail Sidiq - https://orcid.org/0000-0003-3544-0148
Bashir Ahmad Dar - https://orcid.org/0009-0008-8793-5576
Majid Jehangir - https://orcid.org/0000-0001-5130-4889
Razia Hamid - https://orcid.org/0009-0008-2809-7859
Feroze Shaheen - https://orcid.org/0000-0002-8348-8106
Abdul Waheed Mir - https://orcid.org/0000-0003-4467-507X

Source of Support: Nil, **Conflicts of Interest:** None declared.