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Evaluation of ultrasonography-guided indices to assess airway difficulties in obese patients

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ABSTRACT

Background

Pre-anaesthetic evaluation must include airway assessment. In the field of regional anaesthesia, ultrasound is regarded as the gold standard and a priceless tool.

Aims

This study was done to assess the Ultrasonography indices for the prediction of difficulties in the airway in obese patients and associate them with clinical parameters.

Materials and methods

This prospective observational research study was performed in a private medical college, over 4 months. A total of 8 Ultrasound parameters were included, which are skin-to-hyoid distance, tongue thickness, skin-to-midpoint of vocal cords, pre-epiglottic space, skin-to-thyroid isthmus, hyomental distance, anterior soft tissue thickness at the suprasternal notch, and thyromental distance were related with clinical assessment (Cormack-Lehane grading).

Result

Out of the 40 cases examined, 29 (72.5%) were predicted to be challenging during an ultrasound examination of the airways, and 19 (47.5%) were discovered to be challenging during clinical intubation. A total of 5 parameters, which are skin to midpoint of vocal cords (sensitivity 89.6%, specificity 60.3%, cut off value 1.46 cm), pre-epiglottic space (sensitivity 77%, specificity 74.2%, cut off value 0.56 cm), hyomental distance (sensitivity 65.7%, specificity 61.5%, cut off value 7.24 cm), anterior soft tissue thickness (sensitivity 88.7%, specificity 60.3%, cut off value 1.23 cm) and thyromental distance (sensitivity 80%, specificity 61.4%, cut off value 7.2 cm) were clinically correlated.

Conclusion

To predict difficult airways and intubation in obese patients, the following ultrasonography (USG) indices—Skin to the midpoint of vocal cords, Anterior soft tissue thickness at Suprasternal notch, pre-epiglottic space, hyomental distance in mid-extended position, and Thyromental distance—were found to be clinically correlated.

Key-words: Airway Difficulties, Airway indices, clinical, ultrasonography.

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INTRODUCTION

The pre-anaesthetic evaluation must include an airway assessment. Despite the availability of numerous clinical airway assessment tools, the incidence of unexpected difficulties faced during laryngoscopy remains high because of their low reliability. [1] It has been estimated that 1 to 4% of preoperative airway management cases result in difficulties. [2, 3] To aid in the planning of airway management, precise preoperative airway assessment should be carried out. [1]

One of the most crucial techniques for anaesthesiologists to secure the airway during general anaesthesia and resuscitation is endotracheal intubation. Failure to manage airways properly can result in mortality as well as serious ill effects. [2] A helpful, non-invasive tool for airway assessment that can be used in conjunction with clinical techniques is ultrasound (US) of the upper airway. [3] A portable, non-ionizing, non-invasive tool called ultrasound can quickly produce images of the anatomy of the airways. [4] Visualising crucial anatomical structures is the main component of an ultrasound-guided airway assessment. [5] For image generation, ultrasound uses sound waves with a frequency greater than 20,000 Hz. According to ultrasound theory, electrical energy is transformed into mechanical waves that travel through tissues, strike their target, and bounce back. Images are generated on the screen by converting reflected mechanical waves into electrical energy. [5] The benefits of USG include being light, portable, non-invasive, producing reproducible images, being widely available, painless, reasonably priced, easily repeatable, and having a solid safety profile in use by non-radiologists with a relatively quick learning curve. [6]

In peri-operative practice, ultrasound has evolved into a flexible tool for quick bedside assessment.[1] Ultrasonography (USG) is a fast-developing diagnostic tool in the field of anaesthesia for finding applications in airway management. [7] It has been found that Ultrasound is a useful tool not only for the prediction of difficult airway but also for confirmation of placement of Endotracheal tube/laryngeal mask airway, as an adjunct for percutaneous dilatational tracheostomy, percutaneous cricothyroidotomy and for prediction of post-extubation stridor. [8] Airway evaluation before intubation has historically relied on clinical factors like body mass index, neck circumference, and the Mallampati scoring system. [4]

In the reported literature several airway sonographic parameters were observed as potential predictors of challenging laryngoscopy. [9,10] The tongue volume, the thickness of the soft tissues at the hyoid bone's level, the vocal cords, the visibility of the hyoid bone in sublingual ultrasound, and other parameters can all be measured. [3] However, no definite agreement was reached, and the search for a straightforward measurement is still ongoing. [1] Therefore, the purpose of this study was to assess how well USG-guided indices predicted difficult airways in obese patients and how well they correlated with other clinical parameters.

Materials and method

This prospective observational research was carried out in a private medical college over 4 months from March 2021 to June 2021 after ethical approval and informed written approval from the participants. The sample size was estimated based on the previous clinical study taking into consideration an alpha value of 0.05, a beta error of 80%, and a margin of error of 5%. Thus, a total of 40 subjects were included in the study.

Inclusion criteria were; patients of ASA grade I and II, either gender, BMI more than 25 kg/m^2, and those posted for elective surgeries were included in this study. Exclusion criteria were; anterior neck masses, emergency cases, pathology related to teeth, inter incisor distance less than 3 fingers, neck movement restriction, temporo-mandibular joint movement restriction, and gross clinical abnormalities that will predict difficult intubation externally.

All 40 patients were thoroughly evaluated for a pre-anaesthetic check-up, necessary investigations were done, and optimized for the elective surgery. For each patient, a correlation of airway and USG indices was done by a trained anaesthesiologist. All the surgeries were performed under a standard General anaesthesia regimen consisting of drugs glycopyrrolate,

ondansetron, propofol, opioids, neostigmine, and atracurium. After sufficient relaxation, tracheal intubation was done by direct laryngoscopy with a Macintosh blade of appropriate size. The laryngoscopic view was graded by Modified Cormack-Lehane grading. Cormack- Lehane grading at direct laryngoscopy classifies patients into four grades; Grade I: Full exposure of glottic structures (anterior + posterior commissure), Grade II: Anterior commissure can't be visualised, Grade III: Only epiglottis can be visualised, Grade IV: No glottic structure is visible. Patients were graded under the easy category if intubated easily during the first attempt without aids (Grade I and Grade II), mildly difficult (Grade III) and difficult (Grade IV). The Laryngoscopic view was graded as Mildly Difficult if a Stylet was used for intubation, or additional pressure (BURP) was applied to cricoid cartilage during intubation. Patients were graded under a difficult category if aid was used for intubation like Bougie and/or Cormack-Lehane grade III, IV. All the patients recovered uneventfully. All the 40 patients completed the study successfully.

In all the subjects during pre-anaesthetic check-ups, the following USG-guided indices were recorded for airway assessment: USG guided tongue thickness, USG guided Skin to Hyoid distance, USG guided Skin to the midpoint of vocal cords, USG guided Pre-Epiglottic space, USG guided Skin to Thyroid isthmus, USG guided hyomental distance in mid-extended position, USG guided anterior soft tissue thickness at suprasternal notch, USG guided thyromental distance were recorded. Ease of intubation, number of attempts for intubation, use of any aids like Bougie or Stylet, and time taken for intubation (From direct laryngoscopy to cuff inflation time) were noted.

Figure 1:Measurement of sub glottic diameter

Figure 2:measures the maximum tongue thickness.

Figure 3::measures the distance between skin to midpoint of vocal cords.

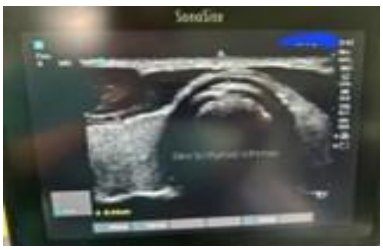

Figure 4:measures distance between skin to thyroid isthmus

Figure 5:measures anterior soft tissue thickness at supra sternal notch.

Statistical evaluation

The obtained data was statistically assessed using IBM SPSS statistical software version 22.0 using paired t-test with $p<0.05$. Sensitivity, Specificity, and cut-off values for a particular airway Ultrasound parameter were assessed by using the ROC curve and Youden Index. Cut-offs were also compared with other observational studies on Ultrasound airway assessment in obese patients.

Result

Number of cases observed with difficult intubation clinically was 19 (47.5%). Subjects were categorized into easy, mildly difficult, and difficult intubation clinically as shown in (Table 1).

Table 1:Mode of intubation

Easy	Mild difficulty	Difficult
16 (40%)	5(12.5%)	19 (47.5%)

Table 2 indicates the correlation between USG and clinical parameters for easy or difficult intubation. The sensitivity and specificity of the parameter Tongue thickness were found to be 88.6% and 45.5% respectively with a cut-off value of 4.48 cm. Pre-epiglottic space had a sensitivity of 77% and specificity of 74.2% with a cut-off value of 0.56 cm. The distance between the skin and to midpoint of the Vocal cords had a sensitivity of 89.6% with a specificity of 60.3% and a cut-off value being 1.46 cm. The parameter Skin to Thyroid isthmus was found to have a sensitivity of 14.7% and specificity of 78% with a cut-off value of 0.65 cm. The parameter anterior soft tissue thickness at suprasternal notch has a Sensitivity of 88.7 % and a Specificity of 60.3 % with a cut-off value of 1.23 cm. The parameter hyomental distance has a Sensitivity of 65.7 % and a Specificity of 61.5% with a cut-off value of 7.24 cm. The parameter Thyromental distance showed a Sensitivity of 80% with a Specificity of 61.4 % and a cut-off value of 7.2 cm (Table 2).

Table 2:Comparison of USG indices cut off, specificity sensitivity with previous studies.

	Parameters observed	Study Cut-off	Previous studies Cut-off (cm)	Easy intub-ation	Difficult intubation	Specifi-city (%)	Sensiti-vity (%)
1	Tongue thickness	4.48cm	6.2	12	22	45.5	88.6
2	Skin to hyoid	0.29cm	1.38±0.17	14	20	65.6	48
3	Skin to mid-point of vocal cords	1.46cm	1.24± 0.12	13	21	60.3	89.6
4	Pre-epiglottic space	0.56cm	0.87± 0.17	17	18	74.2	77

5	Anterior soft tissue thickness at suprasternal notch	1.23cm	1.26± 0.28	13	23	60.3	88.7
6	Skin to thyroid isthmus	0.65cm	1.07± 0.28	25	9	78	14.7
7	Thyromental distance	7.2 cm	6.4	21	15	61.4	80
8	Hyomental distance	7.24cm	5.12± 0.48	17	18	61.5	65.7

Table 3 indicates the difficulties with intubation in correlation with USG and clinically. Intubation difficulties were 29 (72.5%) with USG over 19(47.5%) with clinical evaluation. The difference was statistically significant (0.01).

Table 3:Association of parameters among USG and clinical evaluation

Parameters	USG predicted, N (%)	Clinically Predicted N (%)	p
Easy	11 (27.5%)	21 (52.5%)	0.01
Difficult	29 (72.5)	19 (47.5%)	0.01

DISCUSSION

A quick and painless bedside tool called ultrasonography makes it simple to see the anatomy of the neck and evaluate the airway. [11] Unexpected difficult airways continue to be a major challenge for the medical community despite recent advancements in the field of anesthesiology. Although there is a dearth of literature in this area, sonographic assessment of the upper airway is an emerging tool for the prediction of difficult airways, particularly in emergencies and with unconscious patients, along with anatomic landmarks that are challenging to palpate. The combination of clinical and sonographic parameters demonstrated improved results for the detection of unexpectedly challenging laryngoscopy. [2]Airway ultrasound can be used to predict difficult laryngoscopies non-invasively.[12] Additionally, growing in popularity is the use of ultrasound for managing and evaluating airways. [13]This study's clinical parameters were correlated with ultrasonography-guided indices for predicting airway difficulties in obese patients. In the current study, out of 40 cases, 29 (72.5%) were predicted to be challenging during an ultrasound airway examination, and 19 (47.5%) were discovered to be challenging during a clinical intubation.Recently, a lot of research has been done in the field of evaluation and management of airway which is an important

skill for the Anesthesiologist. [13,14] Ultrasound is being used as an aid in confirming the placement of the endotracheal tube and also in securing the emergency surgical airway.[1 3] Previous research has shown that sonographic predictors can be useful in identifying challenging laryngoscopies. In comparison to the individual tests, the combined clinical and ultrasonographic parameters displayed better validity profiles. [2]According to the study's findings, ANS-E distance is the most significant predictor of a difficult laryngoscopy, and USG is a useful tool for identifying patients who are "at risk" for a difficult airway. [3]Pre-anaesthetic sonographic airway assessment was performed by Gupta et al., and the results were compared to clinical grading. They noticed that while EVC had a negative correlation with the same CL grades, PES had a positive correlation.[15] Shivaji et al stated that Upper airway USG can be a reliable method and can be employed as a standard method for confirmation of ETT location in patients undergoing elective surgeries under general anesthesia when compared to $EtCO_2$. [6] Das et al stated that PRE-E depth/epiglottic vocal cord distance correlated better than the hyomental distance ratio in predicting CL Grading. As measured using ultrasound guidance, the posterior third of the tongue's depth can indicate how difficult a laryngoscopy will be. [16] Reddy et al. from a study concluded that ANSVC >0.23 cm is a potential predictor of difficult intubation and that ultrasound is a useful tool in airway assessment.[17]By measuring the thickness of the anterior neck soft tissue, ultrasonographic parameters can be used to predict difficult airways. In comparison to HMDr and TV, the cut-off value of 0.29 cm at the level of the vocal cords distinguishes between difficult intubation and easy intubation and is a better predictor of difficult intubation. In comparison to individual parameters, combined USG parameters may be the best predictor for challenging individuals.[1]Our study shows that distance between skin to the midpoint of vocal cords, anterior soft tissue thickness measured at suprasternal notch, distance from skin to pre-epiglottic space, hyomental distance and thyromental distance has good sensitivity and specificity in predicting difficult airways. These indices clinically correlated with actual number of difficult intubations found.

LIMITATION

Our study was done with 40 patients. A larger sample size is needed to further validate the result. Our study was done in a single hospital. A multi centric study would also further validate the result. This observational study has been done using a few Ultrasound indices to evaluate the prediction of difficult laryngoscopy and intubation in obese patients. Other parameters can also be studied to validate the result.

CONCLUSION

This study demonstrates the value of ultrasound as a tool for assessing the airways. To predict difficult airways and intubation in obese patients, the following USG indices—Skin to the midpoint of vocal cords, pre-epiglottic space, Anterior Soft Tissue Thickness at Suprasternal Notch, Thyromental distance, and Hyomental distance in mid-extended position—were found to be clinically correlated.

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