Prediction Of Difficult Laryngoscopy In Obese Patients By Ultrasound Quantification Of Anterior Neck Soft Tissue Thickness And Neck Circumference

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Abstract:

Background: Unanticipated difficult intubation remains a primary concern for anaesthesiologists. Theoretically, accurate preoperative airway evaluation can reduce or avoid unanticipated difficult intubation.

Aim: To determine the utility of sonographic measurements of anterior neck soft tissue thickness (at the level of hyoid bone, thyrohyoid membrane and anterior commissure) neck circumference and BMI in distinguishing easy and difficult intubation.

Methods: 60 obese patients with BMI (30kg/m-^{2}) and ASA Grade II and III both sexes, aged between 18 and 70 years, scheduled for different surgeries under general anaesthesia were included in this prospective observational study conducted at the SMHS Hospital which is one of the associated hospitals of Government Medical College Srinagar. Patients selected for surgery were admitted at least 24 hours prior to surgery. The attending anaesthetist evaluate the following variables pre operatively: history of snoring and OSAS, Modified Mallampati score (MMS), loose or protruding upper teeth or partially missing upper incisors or canines; thyromental distance, TM joint mobility, neck mobility, body mass index, neck circumference at the level of thyroid cartilage and USG measurements of anterior neck soft tissue thickness was obtained at three levels.

Results: Mean weight of 66.40±8.15kg in the patients with difficult intubation while as mean weight of 60.50±9.25 among the patients with easy intubation with statistically significant difference among the study population (p=0.001). Mean Body Mass of 40.60±4.8 among the patients with a difficult intubation while as the body mass index of 36.55±3.5 among the patients with an easy intubation with statistically significant difference among the study population (p=0.004). The mean of neck circumference of 45±4.8 among the patients with a difficult intubation and mean of 38±3.2 among the patients with Easy intubation.The statistical difference between the patients was statically significant with a p value= 0.002. The distance between skin and hyoid bone ranged from 1-4 with a mean of 1.91±0.30 and 1-3 with a mean of 1.38± 0.20 among the patients with easy intubation. The statistical difference between the patients was statically significant with a p value= 0.0002. **Conclusion:** Anterior neck soft tissue thicknesses measured by US at hyoid bone, thyrohyoid membrane, and anterior commissure levels are independent predictors of difficult laryngoscopy. Combinations of those screening tests or risk factors with US measurements might increase the ability to predict difficult laryngoscopy.

Keywords: Difficult intubation, Ultrasonography, laryngoscopy, Risk factors, General Anaesthesia.

INTRODUCTION:

Endotracheal intubation is one of the most important skills for anesthesiologists in securing the airway during general anesthesia and resuscitation. Failure to secure the airway can cause anesthesia-related life-threatening morbidity and mortality. Therefore, unanticipated difficult intubation remains a primary concern for anaesthesiologists.[1] Theoretically, accurate preoperative airway evaluation can reduce or avoid unanticipated difficult intubation. However, the difficult laryngoscopy and tracheal intubation rate still remains at 1.5–13% due to poor reliability of traditional protocols, algorithms, and combinations of screening tools in identifying a potentially difficult airway .[2] The adverse effects related to difficult tracheal intubation include hypoxic brain injury, cardio pulmonary arrest, rescue tracheostomy, airway trauma, aspiration, damage to teeth, and death.[3]

Various parameters have been studied in an attempt to establish a better predictor of potential difficult intubation. However, there is no strong consensus and the results are still unclear on true predictors and criteria to be used to predict potential difficult laryngoscopes. [4-6] American society of Anaesthesiologists (ASA) status difficult airway as "the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation or both".[7]

Ultrasound (US) imaging technique has recently emerged as a novel, simple, portable, noninvasive tool helpful for airway assessment and management. Initial few reports published were on soft tissue imaging of neck, focussing on pre tracheal structure and anterior tracheal wall. In the last few years, there have been some reports and a study that described various roles of US imaging in airway management.[8-11] It helps in rapid assessment of the airway anatomy, not only in operation theatre but also in the intensive care unit and emergency department. Various clinical applications of US imaging of the upper airway include identification of endotracheal tube (ETT) placement,[12] guidance of percutaneous tracheostomy[13,14] and cricothyroidotomy,[15] detection of subglottic stenosis,[16] prediction of difficult intubation[17]and post extubation stridor,[18] prediction of paediatric ETT[19] and double lumen tube (DLT) size.[20]

MATERIALS AND METHODS:

Study Design

The present study was conducted at the SMHS Hospital which is one of the associated hospitals of Government Medical College Srinagar. After obtaining approval from Hospital Ethics Committee, a written informed consent was taken from the patients for participation in this study.

Study Setting and Population

The study took place over a period of 18 months for 60 obese patients with BMI (30kg/m-^{2}) and ASA Grade II and III scheduled for different surgeries under general anaesthesia with tracheal intubation were enrolled. Patients selected for surgery were admitted at least 24 hours prior to surgery. Pre-anaesthetic evaluation was done at this stage. Patients were excluded if they had any abnormalities preventing the use of clinical screening tests (facial fractures, maxillofacial abnormalities, tumors, and cervical spine fractures), had a tracheostomy tube, or were unable to give consent.

Study Protocol

Age, gender, weight, height, type of surgery was noted down in all patients. A thorough history including history of any co-morbid disease, previous anaesthetic exposure, medications, allergy to any drugs and personal habits was elicited. All routine investigations like haemoglobin, platelet count, BT/CT, blood urea and serum Creatinine, blood glucose (fasting and random), chest X-ray (P/A view), ECG was checked. The patients were advised to remain fasting overnight.

General physical examination as well as systemic examination of cardiovascular system, respiratory system and central nervous system was performed. Airway assessment was also done to predict any difficult intubation. The attending anaesthetist evaluate the following variables pre operatively: history of snoring and OSAS, Modified Mallampati score (MMS), loose or protruding upper teeth or partially missing upper incisors or canines; thyromental distance, TM joint mobility, neck mobility, body mass index, neck circumference at the level of thyroid cartilage and USG measurements of anterior neck soft tissue thickness was obtained at three levels.

All patients were transported to the operating room with appropriate premedication. On arrival to operating room, an 18‑ gauge intravenous (IV) catheter was inserted and 6ml/kg/h crystalloid was infused intraoperatively, monitoring of electrocardiography, non-invasive blood pressure, oxygen saturation (SpO_2) was started and baseline values were recorded. Pre-oxygenation with 100% oxygen (O_2) was done for 3 min. General anaesthesia was induced with IV propofol 2.0–2.5 mg/kg followed by succinylcholine 2 mg/kg to facilitate orotracheal intubation. The trachea was intubated with a cuffed orotracheal tube of appropriate size. Anaesthesia was maintained with 60% N_2O in oxygen with 0.5–1% isoflurane. Intermittent boluses of atracurium bromide were used to achieve muscle relaxation. Minute ventilation was adjusted to maintain normocapnia (end tidal carbon-dioxide [$EtCO_2$] between 34 and 38 mm Hg) and $EtCO_2$ was monitored.

All the patients were in neutral position without neck overextension or over-bending. The Macintosh blades were used to expose the target larynx, and no external laryngeal pressure was used to facilitate this process. Classification of laryngoscopic views was graded using Cormack and Lehane classification: Grade 1 is full view of glottis, Grade 2 is partial view of glottis or arytenoids, Grade 3 is only epiglottis seen and Grade 4 is neither glottis nor epiglottis visible. Laryngoscopic views grade 1 & 2 are categorised easy. Grade 3 and 4 are categorised difficult.

Grade I and II were categorized as easy laryngoscopy; Grade III and IV were categorized as difficult laryngoscopy.

Statistical Methods

Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Data was analysed by means of descriptive statistics viz, means, standard deviations and presented by Bar diagrams. Chi-square test or Fisher's exact test, whichever appropriate, was used for non-parametric data. A P-value of less than 0.05 was considered statistically significant.

Conflict of interest: Nil

Funding : Nil

RESULTS:

A total of 60 obese eligible patients 66.6% (40) females, 33.3 %(20) males were included in this study. Of all study population 18.3% (11) patients shows difficult intubation and 81.6 %(49) patients represents easy intubation under ultra sound quantification. With regarding demographic profile like age, sex, ASA class and height was comparable among the study population [Table 1].

Table 1: Demographic profile among the population

variables	Difficult Group	Easy Group	P value
Age (years)	47.24±15.4	48.46±12.7	0.55
Sex M/F	4/7	21/28	1.00
ASA II/III	18/7	23/12	0.45
Height	161.11±7.23	160.34±5.48	2.05

Mean weight of 66.40±8.15kg in the patients with difficult intubation while as a mean weight of 60.50±9.25 among the patients with easy intubation and mean of body Mass Indexwas 35.50±7.25 among the patients with a difficult intubation while as the mean of body Mass Index was 33.20±5.50 among the patients with an easy intubation. When the values were compared statistically the difference was found to be significant (p<0.001) [Table 2.

Table 2: BMI/kg/M^2 and weight among the population

variables	Difficult Group	Easy Group	P value
BMI	35.56±7.21	33.18±5.48	<0.001
Weight	66.67±8.19	60.22±9.15	<0.001

Regarding the Modified Mallampatti Score patients shows MMSI, MMSII with statically insignificance values(p>0.001)while as with regard to MMSIII patients represented with statically significance difference among the study population None of the patients shows Modified Mallampatti Score IV (p<0.001) [Table 3].

Table 3: Modified Mallampati Score

variables	Difficult Group	Easy Group	P value
MMS I	9.09%	24.48%	>0.001
MMSII	27	24.48%	>0.001
MMSIII	31.81%	21.05%	<0.001

The neck circumference ranged from 30 to 55 cm with a mean of 42±8 among the patients with a difficult intubation and 33 to 58 cm with a mean of 38±6 among the patients with Easy intubation.The statistical difference among the patients was statically significant with a p value= 0.002 [Fig 1].

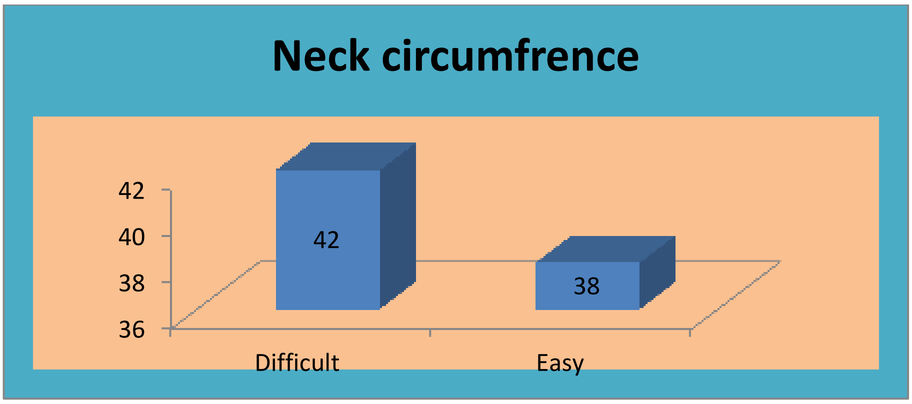

Fig 1

Among the patients with difficult intubation, the distance between skin and hyoid bone ranged from 1-4 with a mean of 1.91±0.30 and 1-3 with a mean of 1.38± 0.20 among the patients with easy intubation. The statistical difference between the patients was statically significant with a p value= 0.0002 [Fig 2].

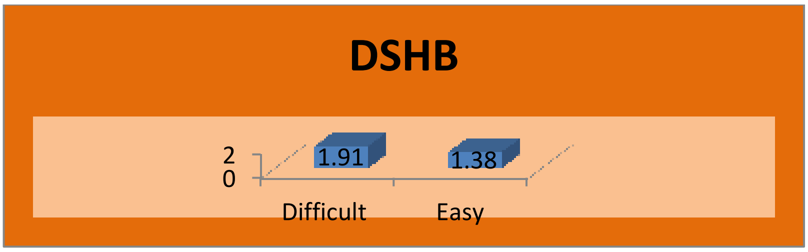

Fig 2

Among the patients with difficult intubation, the distance between skin and epiglottis ranged from 2-4 with a mean of2.79±0.50 and 1-3 with a mean of 1.89± 0.35 among the patients with easy intubation. The statistical difference between the patients was statically significant with a p value= 0.001[Fig3].

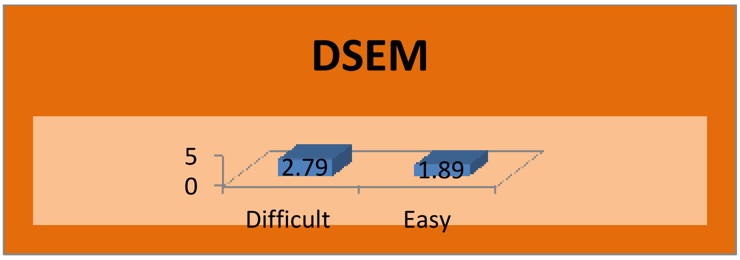

Fig 3

Patients with difficult intubation, the distance between skin and anterior commission ranged from 1-3 with a mean of 1.7±0.35 and 2-3 with a mean of 1.32± 0.30 among the patients with easy intubation. The statistical difference between the patients was statically significant with a p value= 0.0002[Fig4].

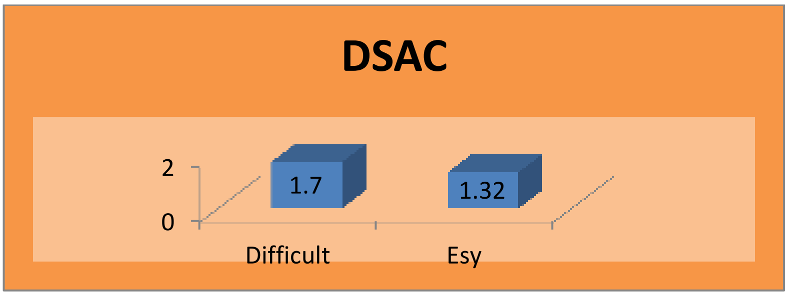

Fig 4

DISCUSSION:

The difficult tracheal intubation is a common source of mortality and morbidity in surgical and critical care settings. There are several traditional indices of predicting difficult laryngoscopy, but none of them are 100% sensitive and specific.[21] Ultrasound is a new addition to the anesthesiologist's armamentarium, which has revolutionized care in several areas. Currently, the role of ultrasound (US) in anaesthesiarelated airway assessment and procedural interventions is encouraging, though it is still ill defined. Ultrasound can visualize anatomical structures in the supraglottic, glottic and subglottic regions. The floor of the mouth can be visualized by both transcutaneous view of the neck and also by transoral or sublingual views. However, imaging the epiglottis can be challenging as it is suspended in air. Ultrasound may detect signs suggestive of difficult intubation, but the data is limited. Other possible applications in airway management include confirmation of correct endotracheal tube placement, prediction of post extubation stridor, evaluation of soft tissue masses in the neck prior to intubation, assessment of subglottic diameter for determination of paediatric endotracheal tube size and percutaneous dilatational tracheostomy. With development of better probes, highresolution imaging, realtime picture and clinical experience, US has become the potential first line noninvasive airway assessment tool in anaesthesia and intensive care practice.[22]

Our results showed that the thicknesses of anterior neck soft tissue at the level of the hyoid bone DSHB (1.91 ± 0.30 cm versus 1.38 ± 0.20 cm; p<0.0002)],the thyrohyoid membrane DSEM (2.79 ± 0.50 cm versus 1.89 ± 0.35 cm; p<0.0001], and the anterior commissure DSAC (1.70 ± 0.35cm versus 1.32 ± 0.30 cm; p<0.00s02) were greater in the difficult laryngoscopy group and were significantly correlated. Furthermore, the ranges of anterior neck soft tissue for those with difficult laryngoscopy were greater than those patients with an easy laryngoscopy, indicating that they are independent predictors of difficult laryngoscopy, This is in accordance with the study done by **Ezri, et al**. who measured the distance from the skin to the anterior aspect of the trachea at three levels: zone 1 (vocal cords), zone 2 (thyroid isthmus), and zone 3 (suprasternal notch) by a mean of soft tissue thickness obtained in central axis and 1.5 mm to the left and right of the central axis in 50 morbidly obese patients. Their study concluded that the zone 1 soft tissue thickness appeared to be the better predictor of a difficult laryngoscopy as there was no overlap in its range in the difficult laryngoscopy group (24-32 mm) and the easy laryngoscopy group (15-22 mm).[23]

Our study also confirmed the work of **Jinhong Wu, et al.** who evaluated the role of anterior neck soft tissue thickness at the level of hyoid bone [minimal distance from the hyoid bone to skin surface (DSHB)], at level of thyrohyoid membrane [distance from skin to epiglottis midway (DSEM) between hyoid bone and thyroid cartilage] and the minimal distance from skin to anterior commissure (DSAC) of vocal cords .[24] They concluded that anterior neck soft tissue thicknesses measured by US at hyoid bone, thyrohyoid membrane, and anterior commissure levels are independent predictors of difficult laryngoscopy.

Hui et al.[25] have recently shown that visibility of hyoid bone on a sublingual ultrasound could be predictive of easy laryngoscopy. Their technique did not take much time to perform, and they showed that the inability to visualize the hyoid bone through a sublingual sonographic scan is predictive of a difficult laryngoscopy.

Aruna Parameswari,et al [26]measured the anteroposterior thickness of the geniohyoid muscle, the skin to hyoid distance, the skin to epiglottis distance at the level of the thyrohyoid membrane, the mentohyoid distance, and the cross sectional area of the muscles of the floor of the mouth by ultrasound and concluded that among the skin to epiglottis distance was most sensitive (sensitivity of 75%) and most specific (specificity of 63.6%) in predicting difficult laryngoscopy.

Our results are in accordance with the conclusion made by **Adhikari et al,[27]**who used ultrasound to determine the utility of sonographic measurements of thickness of the tongue, anterior neck soft tissue at the level of hyoid bone, and the thyrohyoid membrane in distinguishing between easy and difficult laryngoscopy. They demonstrated that sonographic measurements of anterior neck soft tissue thickness at the level of hyoid bone and thyrohyoid membrane can be used to distinguish difficult and easy laryngoscopies.

Among other parameters we evaluated, neck circumference was the other useful predictors of difficult laryngoscopy. Neck circumference of 48±4.8 cms among the patients with a difficult intubation and 38±3.2 cms among the patients with easy intubation with a p value= 0.002. This is in accordance with the study done by **He le ne Gonzalez,** who compared the incidence of difficult tracheal intubation in 70 obese [body mass index (BMI) _30 kg/m2] and 61 lean patients (BMI _30kg/m2) and found that difficult tracheal intubation is more frequent in obese than in lean patients and in these patients thyromental distance, BMI, large neck circumference, and higher Mallampati score were the only predictors of potential intubation problems.[28]

Our results confirmed the work of **Brodsky *et al.[29]*** who showed that neck circumference at the thyroid cartilage is a valuable predictor of difficult laryngoscopy in obese patients.

In our study we found high modified mallampati scores as a risk factor for difficult intubation. 63.63% of the patients show MMSIII Score among the patients with difficult intubation and 16.32% [30] patients shows MMSIII Score among the patients with easy intubation. Thus there was a statistically significant association between MMS with difficult laryngoscopies. This is in accordance with the study of **Prakash et al** who concluded that Mallampati class 3-4, range of neck movement < 80˚, inter-incisor distance ≤ 3.5 cm and snoring were independently related to difficult laryngoscopy. However, **Juvin and collegues [31]** also demonstrated that none of the classic risk factor (the Wilson score, mouth opening, history of OSA) was satisfactory in obese patients except for the Mallampati score. The Mallampati score was consistently reported to be a significant predictor in obese patients including the present study. [32]

Thyromental distance TMD is also used as a screening test to predict difficult airway, but our results suggest that TMD is not a useful screening test. **Tse JC et al**also concluded that these three tests mallampati classification, thyromental distance and head extension are of little value in predicting difficult intubation in adults, although the likelihood of an easy endotracheal intubation is high when they yield negative results. **Butler and Dhara** also found that mallampati and thyromental distance assessments predicted less than two of the three difficult intubation and high false positive rates.

Several limitations exist in our study. Glottis exposure by place laryngoscope is a very complicated procedure, and many subjective and objective factors such as the provider's skills and experience, airway secretions, and abnormalities of anatomical structures are involved in this procedure. Therefore, the small sample size might limit our conclusions. Some clinical signs might indicate the possibility of difficult laryngoscopy, which can cause some bias during US measurements.

CONCLUSION:

Among the potential predictors of difficult laryngoscopy, anterior neck soft tissue thicknesses measured by US at the hyoid bone, thyrohyoid membrane, and anterior commissure levels are independent predictors of difficult laryngoscopy. Other useful predictor was neck circumference.

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