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RESEARCH ARTICLE
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ULTRASOUND GUIDED PREDICTION OF DIFFICULT TRACHEAL INTUBATION: AN OBSERVATIONAL STUDY

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Abstract:

Background: Ultrasonography has emerged as a new airway assessment tool. Unanticipated difficult intubation remains a primary concern for anaesthesiologists. Theoretically, accurate pre-operative airway evaluation can reduce or avoid unanticipated difficult intubation.

Aim: To evaluate the accuracy of pre-operative ultrasound assessment of the neck in predicting difficult airways in patients undergoing elective surgery under general anaesthesia.

Methods: 40 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 68.40±8.15kg in the patients with difficult intubation while as mean weight of 61.50±9.25 among the patients with easy intubation with statistically significant difference among the study population ($p<0.05$). Mean Body Mass of 41.60±4.8 among the patients with a difficult intubation while as the body mass index of 37.55±3.5 among the patients with an easy intubation with statistically significant difference among the study population ($p<0.05$). The mean of neck circumference of 44.9±4.8 among the patients with a difficult intubation and mean of 37.6±3.2 among the patients with Easy intubation. The statistical difference between the patients was statically significant with a ($p<0.05$). 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 ($p<0.02$).

Conclusion: Anterior neck soft tissue thicknesses measured by Ultrasound 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, predictors, General Anaesthesia.

Introduction:

Unanticipated difficult airways are potentially life-threatening and remain a significant concern for clinicians managing the airway.[1] The conventional existing clinical parameters for predicting the difficulties associated with airway management remain limited. Ultrasonography is a simple, non-invasive technique used by anaesthesiologists periopeartively. [2,3]

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.[4] 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.[5]

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 laryngoscopies. [6-8] American society of Anaesthesiologists (ASA) difficult airway as, the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation or both.[9]

Pre-operative ultrasound measurement of the anterior neck soft-tissue thickness at various levels, in combination with the standard screening tests and assessment tools for difficult laryngoscopy, may enhance the prediction of difficult laryngoscopy.[10,11]

This study was aimed to assess the accuracy of pre-operative ultrasound measurements, namely, distance from skin to the hyoid bone (DSHB), distance from skin to the thyroid isthmus (DSTI) and thickness of the base of the tongue (TBT), with conventional clinical assessment tools to predict difficult airway in patients undergoing elective surgery under general anaesthesia.

Methods:

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.

Forty adult patients aged between 18 to 70 years undergoing elective surgeries requiring tracheal intubation under general anaesthesia in various surgical specialities 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 the parameters were noted using a portable ultrasound machine (38 mm broadband [13–6 MHz] linear array transducer [SonoSite Micromaxx SonoSite, Inc., SE Bothwell W.A.]) with the probe placed in the transverse axis.
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 anesthesia was induced with IV propofol 2.0–2.5 mg/kg followed by succinyl choline 2 mg/kg to facilitate orotracheal intubation. The trachea was intubated with a cuffed orotracheal tube of appropriate size. Anesthesia 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. Grade 4 is neither glottis nor epiglottis visible. Laryngoscopic views grade 1 & 2 are categorised easy. Grade 3 and 4 are categorised difficult.

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.

Results:
All patients with regarding to the demographic profile like age, sex, ASA class and height was comparable among the study population. 22.5% (9) patients shows difficult intubation and 77.5% (31) patients represents easy intubation under ultra sound quantification. [Table 1].

variables	Difficult Group n=9	Easy Group n=31	P value
Age (years)	**51.24±14.4**	**50.46±12.7**	**>0.05**
Sex M/F	**5/4**	**14/17**	**>0.05**
ASA II/III	**6/3**	**18/13**	**>0.05**
Height	**162.09±6.23**	**161.34±5.48**	**>0.05**

Mean weight of 68.40±8.15kg and 61.50±9.25 in the patients with difficult and easy intubation respectively, mean of body Mass Index was 41.60±4.8 among the patients with a difficult intubation while as the mean of body Mass Index was 37.55±3.5 among the patients with an easy intubation with statistically significant differences ($p<0.001$) [Table 2].

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

variables	Difficult Group	Easy Group	P value
BMI	41.60±4.8	37.55±3.5	**<0.001**
Weight	68.40±8.15kg	61.50±9.25	**<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 (p<0.001) . None of the patients shows Modified Mallampatti Score IV [Table 3].

Table 3: Modified Mallampati Score

variables	Difficult Group	Easy Group	P value
MMS I	**11.09%**	**22.48%**	**>0.001**
MMSII	**25**	**23.48%**	**>0.001**
MMSIII	**28.81%**	**19.05%**	**<0.001**

The mean of neck circumference of 44.9±4.8 among the patients with a difficult intubation and mean of 37.6±3.2 among the patients with Easy intubation. The statistical difference between the patients was statically significant with a (p<0.05). 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<0.01) [Fig 1].

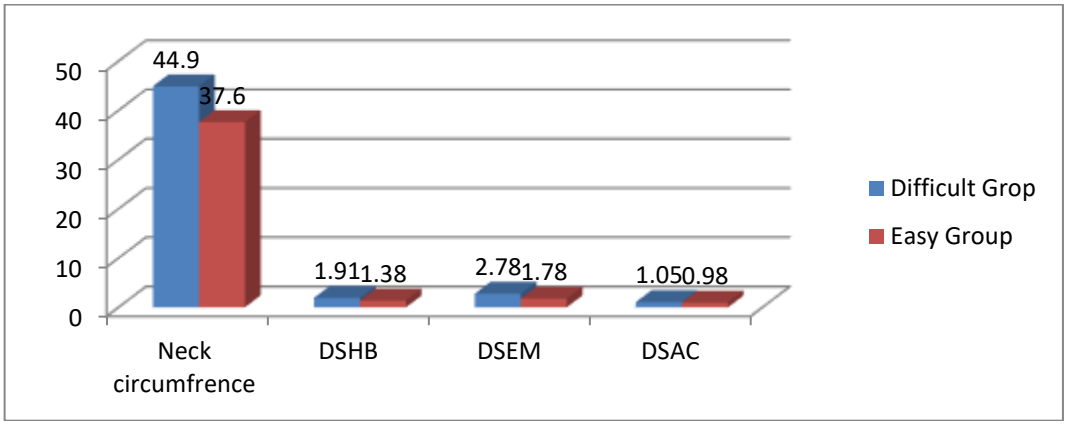

Fig 1.

Discussion:

Quantification of neck soft tissue at the level of the vocal cords and suprasternal notch was the best predictor of difficult laryngoscopy, with no overlap in values for the difficult and easy laryngoscopies. MRI and CT scans have been used to demonstrate the presence of abundant soft neck tissue in the pharynx, retropharynx, suprascapular region, and lateral neck region of obese patients. [12,13] However, MRI and CT scans are costly, may involve some risks to the patients, and require excessive time to be practical. Instead, we describe a novel means of predicting difficult laryngoscopy in obese patients: ultrasound quantification of the anterior neck soft tissue. Neck ultrasound measurements are as accurate as MRI for quantification of fat depth [14], but are inexpensive, rapid, and easy to perform.

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 (2.78 ± 0.50 cm versus 1.78 ± 0.35 cm; p<0.0001], and the anterior commissure DSAC (1.05 ± 0.35cm versus 0.98 ± 0.30 cm; p<0.001) 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).[15]

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 .[16] 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.[17] 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.
In summary, we report the results of 40 morbidly obese patients in whom 9 had difficult laryngoscopy. Among the potential predictors of difficult laryngoscopy, the amount of pretracheal soft tissue was the only measure that fully distinguished easy laryngoscopies from difficult one. Other useful predictors were neck circumference and a history of sleep apnoea. These results suggest that pre-tracheal soft tissue, as assessed by ultrasound, warrants additional study as a predictor of difficult laryngoscopy in morbidly obese patients.

Conclusion:
Anterior neck soft tissue thickness measured by USG at the hyoid bone, and anterior commissure levels combined with the screening tests and risk factors might increase the ability to predict difficult airways.

Conflict of interest: Nil
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