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Research Article

USG GUIDED ASSESSMENT OF ANTERIOR SOFT-TISSUE THICKNESS OF NECK FOR PREDICTION OF DIFFICULT INTUBATION IN MALE POPULATION ONLY: PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Objective: The use of ultrasound (US) imaging for anatomical evaluation has been an exciting technological advancement in the field of anesthesia. The growing utilization of the US is due to its proven clinical effectiveness, cost-effectiveness, and practicality. This technology allows anesthesiologists to assess complex and diverse anatomy.

Methods: In a prospective observational study, US was used to measure the airway dimensions of 100 male patients. The study included assessing the minimal distance from the hyoid bone to the skin surface (DSHB-HB), the distance from the skin to the midway point between the hyoid bone and thyroid cartilage (DSEM-TM), and the minimal distance from the skin to the anterior commissure (DSAC-AC). These patients were scheduled for surgery under general anesthesia after giving informed written consent. The relationship between easy and difficult laryngoscopy and categorical variables was analyzed using the Pearson Chi-square test and Fisher's exact test. A $p<0.05$ was considered significant.

Results: No significant difference in body mass index values in the easy and difficult laryngoscopy group. Out of 100 male patients, 80 were (80%) in the easy laryngoscopy group and 20 were (20%) in the difficult laryngoscopy group. The mean distances were 62.81 ± 22.82 mm, 41.09 ± 22.33 mm, and 39.30 ± 14.97 mm, respectively, for DSHB-HB, DSEM-TM, and DSAC-AC. There is a significant association between easy and difficult laryngoscopy and the increased distance from the hyoid bone to the skin surface, the distance from the skin to the epiglottis midway, and the distance from the skin to the anterior commissure ($p<0.05$).

Conclusion: US-assisted evaluation of the airway by the anesthesiologist has significant advantages compared to relying solely on clinical assessment.

Keywords: Anterior soft-tissue thickness, Difficult intubation, Laryngoscopy.

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INTRODUCTION

The primary responsibility of an anesthesiologist is to make sure that the patient has appropriate gas exchange. If this vital oxygenation is not maintained for more than a few minutes, it can result in irreversible anoxic injury. Estimates suggest that up to 30% of deaths directly related to anesthesia are due to the inability to effectively manage a difficult airway (DA) [1].

The term "Difficult Airway" covers a broad range of clinical situations. This may involve problems with providing mask ventilation or difficulties with intubating the trachea. The worst-case scenario of being unable to intubate and unable to oxygenate poses the highest risk of brain damage or death. The laryngeal inlet appearance during direct laryngoscopy is best described by the Cormack and Lehane (CL) grading system. Difficult direct laryngoscopy is most commonly defined as a presence of Grade 3 or 4 view on laryngoscopy. Difficult direct laryngoscopy is often associated with difficult intubation in most patients. Kheterpal and associates defined difficult intubation as intubation requiring more than three attempts by anesthesia attending staff to secure the airway with an endotracheal tube and difficult laryngoscopy is defined as a CL Grade 2 or 3 view requiring multiple attempts or blades, however, most patients are successfully intubated [2-5]. Unsuccessful intubation with direct laryngoscopy occurs at a rate of 5–35/10,000 anesthesias and the cannot intubate, cannot ventilate scenario occurs at a rate of 0.01–2/10,000 anesthesias [5]. Hence, we can see that the management of a difficult intubation, and more importantly, the prediction of a difficult intubation have far-reaching consequences both intraoperatively as well as postoperatively, in improving enhanced recovery after surgery, as well as overall morbidity and mortality. Air does not conduct ultrasound (US), the probe must be in full contact with the skin or mucosa without any interfacing air [6]. This can be achieved by applying adequate amounts of conductive gel between the probe and skin. Hyoid bone is a landmark structure and separates the upper airway into the suprahyoid and infrahyoid regions. It is visible in on the transverse view as a superficial, hyperechoic, inverted U-shaped, linear structure with posterior acoustic shadowing. Distance between skin and hyoid bone (DSHB), anterior commissure of the larynx is the anterior junction point of the true vocal cords. It is bounded anteriorly by the thyroid cartilage and is part of the laryngeal glottis. Distance between skin and anterior commissure (DSAC) and the true vocal cords appear as two triangular, hypoechoic structures (the vocalis muscles) outlined by the hyperechoic vocal ligaments. They are observed to oscillate and move toward the midline during phonation [7]. Distance between skin and thyrohyoid membrane (DSEM) and the thyrohyoid membrane is runs between the caudal border of the hyoid bone and the cephalad border of the thyroid cartilage.

Aims

Analyze if neck soft-tissue thickness measured by ultrasonography (USG) can predict difficult intubation and use US to measure the thickness of anterior soft tissue at specific neck points: Hyoid bone (DSHB), thyrohyoid membrane (DSEM), and anterior commissure (DSAC) levels, to predict difficult intubation and correlate the findings with CL score.

METHODS

This observational study took place at a tertiary care medical institution after receiving approval from the Institutional Ethical Committee (Ref/no/GGMC/IEC/PG/20/Mar/2017). The study encompassed 100 patients scheduled for surgery under general anesthesia, following their provision of informed written consent. The study focused on male adult patients, aged 20–50, with American Society of Anesthesiologists (ASA) Grade I and II, who required general anesthesia for elective procedures. Female patients, as well as those with ASA >2, emergency surgeries, a history of specified surgical trauma, edentulous, and arthritis, were not included in the study. Based on the study conducted by Wu *et al*. [8], the sample size was calculated based on the correlation between anterior neck soft-tissue thickness at the level of thyrohyoid membrane and vocal cord, with 80% power, an alpha error of 5%, assuming a population correlation coefficient of 0.5%, and the total sample size calculated as 100 patients.

US measurements will be performed by the primary investigator with the patient supine and the head and neck in neutral position. The thicknesses of anterior neck soft tissue at hyoid bone, thyrohyoid membrane, and anterior commissure levels will be obtained transversely across the anterior surface of the neck with a 13–6 MHz HFL 38× linear array US probe attached to a SonoSite S-nerve machine (SonoSite Inc., Bothell, WA, USA). At hyoid bone level, the minimal distance from the hyoid bone to skin surface (DSHB-HB), at thyrohyoid membrane level, the distance from skin to epiglottis midway (DSEM-TM) between the hyoid bone and thyroid cartilage and at the anterior commissure level, the minimal distance from skin to anterior commissure (DSAC-AC) will be obtained.

After anesthesia induction with midazolam 0.04 mg/kg, propofol 2–2.5 mg/kg, fentanyl 2–4 μg/kg, and succinylcholine 2 mg/kg, endotracheal intubation will be carried out by qualified anesthesia providers. All the patients will be in neutral position without neck overextension or over-bending. The Macintosh blades will be used to expose the target larynx, and no external laryngeal pressure will be used to facilitate this process. Classification of laryngoscopic views will be based on the modified CL score. Grade I is a full view of the glottis. Grade II (IIA and IIB) is partial view of the glottis or arytenoids. Grade III (IIIA and IIIB) is only epiglottis seen. Grade IV is neither glottis nor epiglottis visible. Grade I and II are categorized as easy laryngoscopy. Grade III or IV are categorized as difficult laryngoscopy. Descriptive statistics included frequency and percentage for categorical variables and mean±standard deviation for continuous variables. The Pearson Chi-square test and Fischer exact test were applied to find the relationship between easy and difficult laryngoscopy when compared with the outcome for categorical variables. A p<0.05 was considered significant.

Intubation difficulty scale

The difficulty of intubation as enumerated by the intubation difficulty scale incorporates seven factors [9]:

1. N1-Number of attempts >1
2. N2-Number of operators >1
3. N3-Number of alternative techniques
4. N4- CL grade (grade 1 to grade 4 given 0 to 3 points)
5. N5-Lifting force required (normal 0 or increased 1)
6. N6-Laryngeal pressure (not applied 0 or applied 1)
7. N7-Vocal cord mobility (abduction 0 or adduction 1).

RESULTS AND ANALYSIS

A total of 100 male patients were included in this study. The basic demographic characteristics are shown in Table 1. Using the CL grades assigned during direct laryngoscopy, the patients were divided into 80 patients (80%) in the easy group and 20 patients (20%) in the difficult group. Distribution of body mass index (BMI) among easy and difficult laryngoscopy but there is no significant difference BMI values in easy and difficult laryngoscopy group Figs. 1 and 2. Clinical parameters such as MMPC and CL grades are shown in Table 1.

The US parameters DSHB, DSEM, and DSAC are recorded in Table 2.

Table 1: Demographic features of participants

Demographic feature	n,%
Age (years) (mean±SD)	34.7±8.3
ASA (PS)	
Class I (n)	66,66
Class II (n)	34,34
MMPC	
Class 1 (n)	28,28
Class 2 (n)	64,64
Class 3 (n)	7,7
Class 4 (n)	1,1
Cormack Lehane Grade	
Easy laryngoscopy	
1 (n)	47,47
2A (n)	21,21
2B (n)	12,12
Difficult laryngoscopy	
3A (n)	14,14
3B (n)	4,4
4 (n)	2,2

Data are expressed in n-number,%-percentages and mean±SD

Table 2: Mean value of all USG-determined anterior soft-tissue thickness of neck distances

USG determined distance in mm	Mean±SD
Distance from the hyoid bone to skin surface in mm (DSHB)	62.81±22.82
Distance from skin to epiglottis midway in mm (DSEM)	41.09±22.33
Distance from skin to anterior commissure in mm (DSAC)	39.30±14.97

USG: Ultrasonography. Data are expressed in Mean±SD, distances in millimeters

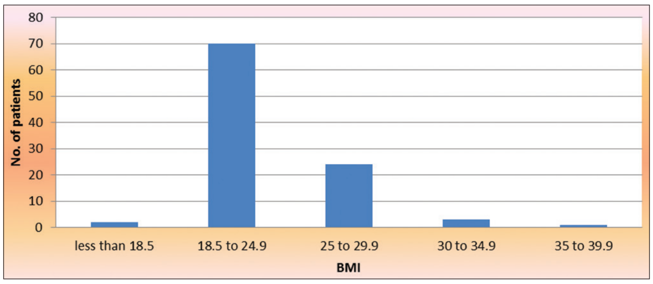

Fig. 1: Distribution of body mass index

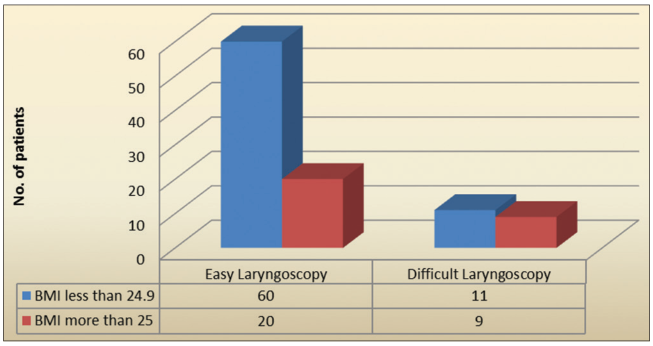

Fig. 2: Association between body mass index and laryngoscopy χ^2- 3.453, df-1, p>0.05 (non-significant)

Table 3: Association of laryngoscopy and various anterior soft-tissue thickness of neck

Laryngoscopy (N,%)		Distance from the hyoid bone to skin surface (DSHB) in mm										X^2	df	p-Value
		31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	More than 110	Total			
Easy Laryngoscopy	Count(n)	7	40	9	5	6	7	4	1	1	80	20.02	8	0.01**
	Percentage	8.80	50.00	11.30	6.30	7.50	8.80	5.00	1.30	1.30	100.00			
Difficult Laryngoscopy	Count(n)	1	1	0	1	1	5	9	1	1	20			
	Percentage	5.00	5.00	0.00	5.00	5.00	25.00	45.00	5.00	5.00	100.00			

Laryngoscopy (N,%)		Distance from skin to epiglottis midway in mm (DSEM)											X^2	df	p-value
		21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	More than 110	Total			
Easy Laryngoscopy	Count(n)	4	48	9	7	1	4	1	3	3	0	80	37.905	9	0.01**
	Percentage	5.00	60.00	11.30	8.80	1.30	5.00	1.30	3.80	3.80	0.00	100.00			
Difficult Laryngoscopy	Count(n)	0	1	3	8	0	5	0	1	0	2	20			
	Percentage	0.00	5.00	15.00	40.00	0.00	25.00	0.00	5.00	0.00	10.00	100.00			

Laryngoscopy (N,%)		Distance from skin to anterior commissure in mm (DSAC)											X^2	df	p-value
		21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	More than 110	Total			
Easy Laryngoscopy	Count(n)	17	46	9	5	1	1	0	0	1	80	17	20.02	8	0.01**
	Percentage	21.30	57.50	11.30	6.30	1.30	1.30	0.00	0.00	1.30	100.00	21.30			
Difficult Laryngoscopy	Count(n)	0	9	4	5	0	0	1	1	0	20	0			
	Percentage	0.00	45.00	20.00	25.00	0.00	0.00	5.00	5.00	0.00	100.00	0.00			

Data is expressed in n-Numbers,%-Percentages ,mm-millimeters, χ^2-Chi square, df-Degree of Freedom and p<0.001 is considered highly significant

There is a significant association in easy and difficult laryngoscopy with increased distance from the hyoid bone to the skin surface (DSHB), distance from skin to epiglottis midway (DSEM) and distance from skin to the anterior commissure (DSAC) p<0.05 (Table 3).

DISCUSSION

Anesthesiologists continue to face challenges when dealing with unexpected DAs while securing the airway. The introduction of anatomical evaluation using US imaging has been one of the most exciting recent technological advances in the field of anesthesia. The increasing use of US has been attributed to its proven clinical efficacy, cost-effectiveness, and practicality, as it allows anesthesiologists to evaluate complex and varied anatomy [10]. US imaging is safe (non-ionizing radiation, no contrast agent), non-invasive, portable, widely available, painless, easily reproducible, and provides real-time dynamic images [11-14]. Although deemed safer than other imaging methods, exposure to high-energy US should be minimized to reduce tissue heating and damage [10].

Wu *et al*. studied 203 non-obese Chinese Han patients undergoing surgeries. They found that 13.8% had difficult laryngoscopy and greater anterior neck soft-tissue thickness at the level of the hyoid bone [8].

Results by Komatsu *et al*., Ezri *et al*., El-Ganzouri *et al*., and Adhikari *et al*., do not significantly correlate with BMI, which is consistent with our findings [15-19].

Our results are similar to the study conducted by Wu *et al*. which concluded that the anterior neck soft-tissue thickness as measured by USG at hyoid bone, thyrohyoid membrane, and anterior commissure are independent predictors of difficult laryngoscopy [8].

Adhikari *et al*. further measured the anterior neck soft tissue at the hyoid bone and thyrohyoid membrane levels, which is important to displace the glottis by the laryngoscopic blade, and found that US measurements of anterior neck soft-tissue thickness at the level of hyoid bone and thyrohyoid membrane can be used to predict difficult laryngoscopies and a 2.8-cm US measurement at the thyrohyoid membrane was a good independent predictor of difficult laryngoscopy [19].

Neck US measurements are as accurate as magnetic resonance imaging for quantification of fat depth, but are inexpensive, rapid, and easy to perform [20].

In a meta-analysis Bajracharya *et al*., in non-obese and obese patients, visibility of the hyoid bone in sublingual US, soft-tissue thickness at the level of the hyoid bone, epiglottis, vocal cords, and suprasternal notch, as well as distance between skin and mid epiglottis at the level of the thyrohyoid membrane are independent predictors of difficult laryngoscopy (CL grade 3 and 4) [21].

Limitations

Patient included in the study with BMI >30 kg/m^{-2} was limited.

CONCLUSION

Every anesthesiologist should have the knowledge to identify and manage a DA. There are various methods available for pre-operative evaluation and recognition of a DA. Many traditional clinical parameters do not accurately predict a DA, which can lead to difficult intubation. Thus, US-assisted pre-operative evaluation of patients' airways may complement traditional methods of pre-operative airway assessment. The ready availability and accessibility of US machines to most anesthesiologists make this an attractive option for pre-operative airway assessment. Research has shown that the thickness of the anterior soft tissue at the levels of the hyoid bone, thyrohyoid membrane, and anterior commissure are individual predictors of difficult intubation.

REFERENCES

1. Cheney FW, Posner KL, Lee LA, Caplan RA, Domino KB. Trends in anesthesia-related death and brain damage: A closed claims analysis. Anesthesiology. 2006;105(6):1081-6. doi: 10.1097/00000542-200612000-00007, PMID 17122570
2. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984;39(11):1105-11. doi: 10.1111/j.1365-2044.1984.tb08932.x, PMID 6507827
3. Kheterpal S, Han R, Tremper KK, Shanks A, Tait AR, O'Reilly M, *et al*. Incidence and predictors of difficult and impossible mask ventilation. Anesthesiology. 2006;105(5):885-91. doi: 10.1097/00000542-200611000-00007, PMID 17065880
4. Kheterpal S, Martin L, Shanks AM, Tremper KK. Prediction and outcomes of impossible mask ventilation: A review of 50,000 anesthetics. Anesthesiology. 2009;110(4):891-7. doi: 10.1097/ALN.0b013e31819b5b87, PMID 19293691
5. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, *et al*. The Intubation Difficulty Scale (IDS): Proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology. 1997;87(6):1290-7. doi: 10.1097/00000542-199712000-00005, PMID 9416711
6. Rose DK, Cohen MM. The airway: Problems and predictors in 18500 patients. Can J Anaesth. 1994;41(5):372-83. doi: 10.1007/BF03009858
7. Sites BD, Brull R, Chan VW, Spence BC, Gallagher J, Beach ML, *et al*. Artifacts and pitfall errors associated with ultrasound-guided regional anesthesia: Part II. A pictorial approach to understanding and avoidance. Reg Anesth Pain Med. 2007;32:419-33.
8. Singh M, Chin KJ, Chan VW, Wong DT, Prasad GA, Yu E. Use of sonography for airway assessment: An observational study. J Ultrasound Med. 2010;29(1):79-85. doi: 10.7863/jum.2010.29.1.79, PMID 20040778
9. Wu J, Dong J, Ding Y, Zheng J. Role of anterior next soft tissue quantifications by ultrasound in predicting difficult laryngoscopy. Med Sci Monit. 2014;20:2343-50.
10. Kristensen MS, Teoh WH, Graumann O, Laursen CB. Ultrasonography for clinical decision-making and intervention in airway management: from the mouth to the lungs and pleurae. Insights Imaging. 2014;5(2):253-79. doi: 10.1007/s13244-014-0309-5, PMID 24519789
11. Gupta PK, Gupta K, Dwivedi AN, Jain M. Potential role of ultrasound in anesthesia and intensive care. Anesth Essays Res. 2011;5(1):11-9. doi: 10.4103/0259-1162.84172, PMID 25885294
12. Adi O, Chuan TW, Rishya M. A feasibility study on bedside upper airway ultrasonography compared to waveform capnography for verifying endotracheal tube location after intubation. Crit Ultrasound J. 2013;5:7.
13. Al-Abed MA, Antich P, Watenpaugh DE, Behbehani K. Upper airway occlusion detection using a novel ultrasound technique. Annu Int Conf IEEE Eng Med Biol Soc. 2012;2012:5650-3. doi: 10.1109/EMBC.2012.6347276, PMID 23367211
14. Ding LW, Wang HC, Wu HD, Chang CJ, Yang PC. Laryngeal ultrasound: A useful method in predicting post-extubation stridor. A pilot study. Eur Respir J. 2006;27(2):384-9. doi: 10.1183/09031936.06.00029605, PMID 16452597
15. Komatsu R, Sengupta P, Wadhwa A, Akça O, Sessler DI, Ezri T, *et al.* Ultrasonographic quantification of anterior soft tissue thickness fails to predicts difficult laryngoscopy in obese patients. Anaesth Intensive Care. 2007;35(1):32-7. doi: 10.1177/0310057X0703500104, PMID 17323663
16. Ezri MB, Weisenberg M, Szmuk P, Warters RD, Charuzi I. Increased body massage index per se is not a predictor if difficult laryngoscopy. Can J Anaesth. 2003;50:179-83.
17. Ezri T, Gewürtz G, Sessler DI, Medalion B, Szmuk P, Hagberg C, *et al*. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia. 2003;58(11):1111-4.
18. El-Ganzouri AR, McCarthy RJ, Truman KJ, Tanck EN, Ivankovich AD. Preoperative airway assessment: Predictive value of a multivariate risk index. Anesth Analg. 1996;82(6):1197-204.
19. Adhikari S, Zeger W, Schmier C, Crum T, Craven A, Frrokaj I, *et al.* Pilot study to determine the utility of point-of-care ultrasound in the assessment of difficult laryngoscopy. Acad Emerg Med. 2011 Jul;18(7):754-8.
20. Abe T, Kawakami Y, Sugita M, Yoshikawa K, Fukunaga T. Use of B-mode ultrasound for visceral fat mass evaluation: Comparisons with magnetic resonance imaging. Appl Human Sci. 1995;14(3):133-9. doi: 10.2114/ahs.14.133, PMID 7641063
21. Bajracharya GR, Truong AT, Truong DT, Cata JP. Ultrasound-assisted evaluation of the airway in clinical anesthesia: Past, present and future. Int J Anesthesiol Pain Med. 2015;1(1):2.