International Journal of Research and Review
Vol.8; Issue: 1; January 2021
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Ultrasound Assessment of Anterior Neck Soft Tissue Thickness as a Predictor of Difficult Laryngoscopy and Intubation in Obese Patients

Deepika Kesarwani[1], Neha Chandrakar[2], Ruqaiya Bano[3], Vijay Vohra[4]

[1]Senior Resident Department of Anesthesia and Critical Care, VMMC & Safdarjung Hospital, New Delhi.
[2]Consultant Ramakrishna Hospital,
[3]Senior Resident Anesthesia & Critical Care, VMMC & Safdarjung Hospital, New Delhi
[4]Chairman of Liver Transplant Medanta-The Medicity Hospital

Corresponding Author: Deepika Kesarwani

ABSTRACT

Background and objective: Maintaining a patent airway is essential for adequate oxygenation and ventilation and it can be life threatening on its failure. Unanticipated difficult intubation being a dreaded concern for the anaesthesiologist. Although obesity increases the risk of difficult intubation but BMI alone is not a good predictor of difficult laryngoscopy. Ultrasound has long been used as a noninvasive and safe tool for diagnosis and assessment of airway. Aim of the study was to determine if ultrasound assessment of anterior neck soft tissue thickness at the level of vocal cord can be used to assess the difficult airway.

Method: 70 morbidly obese patients (BMI>35 kg/m^2) were allocated in 2 groups, Group 1 (easy laryngoscopy) and group 2 (difficult laryngoscopy) for prospective observational study scheduled for elective surgery under general anaesthesia with tracheal intubation. Preoperative work up with airway assessment as mouth opening, thyromental distance, neck circumference, Mallampati grading (MO, TMD, NC, MPG) and anterior neck soft tissue thickness by USG at the level of vocal cord were done. Cormack-Lehane grading with laryngoscope were assessed intraoperatively.

Result: Average Soft tissue thickness at the level of vocal cord by USG in group 1(18.3±1.1) and in group 2 (18.6±0.9) and the difference was not statistically significant (p value 0.317) which showed Cormack-Lehane grading is not affected by anterior neck soft tissue thickness. Also no significant difference was found in respect to mouth opening (p value 0.059). Significant difference was found in both the group (easy and difficult laryngoscopy) in respect to TMD (p value 0.032), MPG (p value 0.002) and NC (p value 0.001).

Conclusion: USG assessment of anterior neck soft tissue thickness at the level of vocal cord is not a good predictor of difficult laryngoscopy in obese patients. But this is a small observational study. Other larger randomization studies are required to prove significant results. Among the potential predictors of difficult laryngoscopy MPG, TMD and neck circumference were the only measures that fully distinguished difficult laryngoscopy from easy one.

Keywords: morbid obese, ultrasound, airway assessment.

INTRODUCTION

The American Society of Anaesthesiologists (ASA) has defined the difficult airway as "The clinical situation in which conventionally trained anaesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation or both" [1]. An unanticipated difficult intubation being a dreaded concern for the anaesthesiologist. It has been observed that the incidence of difficult intubation is three times higher in obese patients than that amongst non-obese patients [2,3]. Although obesity increases the risk of difficult intubation but BMI alone is not a good predictor of difficult laryngoscopy [4,5,6]. In vast majority of

difficult intubations, 98% or more may be anticipated by performing a thorough evaluation of the airway during preoperative assessment. Various parameters that predict difficult intubation in obese patients are history of sleep apnea [5,6], high Mallampati score [5,6], thyromental distance <6 cm [5], male gender [5], increased age, limited neck movement [5], short neck and prominent upper teeth [5]. Ultrasound has long been used as a noninvasive and safe tool for diagnosis and assessment. Studies using ultrasound to assess soft tissue thickness found that patients with difficult laryngoscopy had thicker neck soft tissue at the level of vocal cord and suprasternal notch [7]. While a similar study found that thickness of pre-tracheal soft tissue measured by USG at the level of vocal cord only, was not a good predictor of difficult laryngoscopy [8]. Another study measuring soft tissue thickness at different levels namely hyoid bone, thyrohyoid membrane and anterior commissure concluded that they all are independent predictors of difficult laryngoscopy and a combination of all might increase the ability to predict difficult laryngoscopy [9].

We therefore tried to predict difficulty level during laryngoscopy and intubation in obese patients by quantifying anterior neck soft tissue thickness at the level of vocal cord using ultrasound.

AIMS AND OBJECTIVE:

Aim: To determine if ultrasound assessment of anterior neck soft tissue thickness at the level of vocal cord can be used to assess the difficult airway.

Primary objective: Assessment of airway by using ultrasound, its association and prediction of difficult laryngoscopy.

Secondary objective: Assessment of other airway parameters like MPG, TMD, Mouth opening, NC, BMI, age, gender and its association with difficult laryngoscopy.

Statistical Methods: study design: prospective observational study

Patients and Method: Formula for sample size

$$\mathbf{n = [(\sigma^2_1 + \sigma^2_2)^* (Z\alpha + Z\beta)^2]/ \Delta^2 = 70}$$

(With 95% confidence level and 90% power)

The sample size suggested was 70.

Patients were distributed in 2 groups: Group 1: easy laryngoscopy with CL grading ≤ 2

Group 2 include difficult laryngoscopy with CL grading >2

Criteria for exclusion were Patient Refusal, Upper airway pathology, cervical spine fracture, Full stomach, Pregnant patients.

METHODOLOGY

After approval from the institutional ethical committee, informed and written consent was obtained from all the patients preoperatively detailed history, general physical and airway examination was done to anticipate the possibility of difficult intubation. The parameter that were assessed are: Age, Gender, Height, Weight, BMI, History of sleep apnea, MO, MPG, TMD with the neck extended, NC at the level of thyroid cartilage by using standard tape measure.

Ultrasound assessment of airway was done by radiologist who has experience of at least 5 years. Anterior neck soft tissue thickness was performed with the help of linear probe at a frequency of 13-6 MHz (company – Fujifilm, model – Sonosite M-turbo). The distance from the skin to the anterior aspect of airway was measured at the level vocal cords anterior to thyroid cartilage with patient supine and a pillow below the shoulder to extend the neck. The amount of soft tissue was measured at central axis, 15 mm right and 15 mm left to the central axis and average of all were taken into consideration.

Diagram 1: Measurement of anterior neck soft tissue thickness at the level of vocal cord

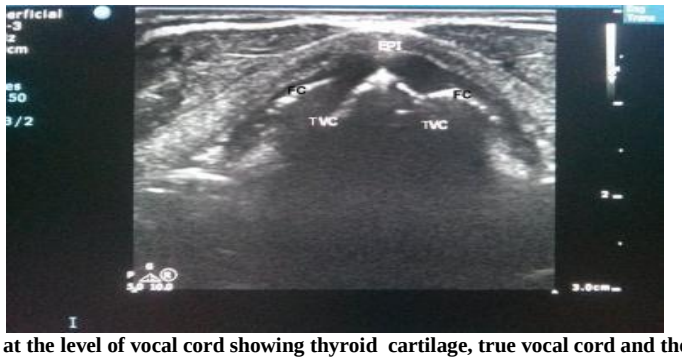

Diagram 2: Axial section at the level of vocal cord showing thyroid cartilage, true vocal cord and the false vocal cord

After checking adequate NPO status and vitals, patient was taken for surgery. Anesthesia was induced by standard technique. After induction laryngoscopy was performed (by anaesthesiologist with experience of at least 2 years and not aware of ultrasound results) by Macintosh blade no.3 or 4 (depending on neck length) and CL grading was recorded. Endotracheal intubation was done with appropriate tube size in sniffing position with pillow below the shoulder. Tube position was checked by capnography and also by auscultatory method. CL grading 1 or 2 were considered as easy and CL grading 3 or 4 as difficult laryngoscopy.

RESULTS AND OBSERVATION

Group 1: Easy laryngoscopy group (CL grading ≤2)

Group 2: Difficult laryngoscopy group (CL grading >2)

The study was conducted in 70 obese patients (BMI>35). When anterior neck soft tissue thickness was calculated, it was found that mean value of average soft tissue thickness is 18.3±1.1 mm in group1 and 18.6±0.9 mm in group 2. No significant difference were found between both the groups (P value=0.317) also no significant difference were found in demographic profile as age, sex, BMI and sleep apnea (p value >0.05) (table1 & 2)

On comparison of MPG, TMD and NC in both the groups it was found to be significant (p value >0.05) it means patients with MPG grade 3, less thyromental distance (<6cm) and larger neck circumference have difficult laryngoscopy (Table 1 & 2)

Multivariable logistic regression analysis with laryngoscopy grade 3 and 4 indicated that only TMD (0.033) was found to be independent predictor of difficult laryngoscopy otherwise none of other factors were found to be independent predictors. (Table 3)

TABLE 1

	Group 1 (CL≤2) (n=51)	**Group 2 (CL>2) (n=19)**	**p value**
Age (yrs)	47.88 ± 12.1	49.95 ± 12.23	0.529
BMI (kg/m^2)	41.99 ± 6.4	43.82 ± 8.23	0.328
MO (cm)	4.64 ± 0.71	4.28 ± 0.58	0.059
NC (cm)	44.85± 4.71	49.11± 4.58	0.001
Central axis(mm)	14.4±0.9	14.9±1.2	0.064
Right (15mm)	20.2±1.3	20.2±1.0	0.938
Left (15mm)	20.3±1.4	20.6±1.2	0.334
Average(mm)	18.3±1.1	18.6±0.9	0.317

P value <0.05 statistically significant

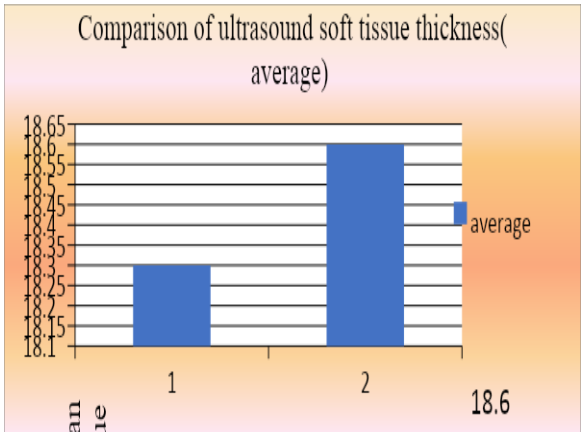

Figure 1

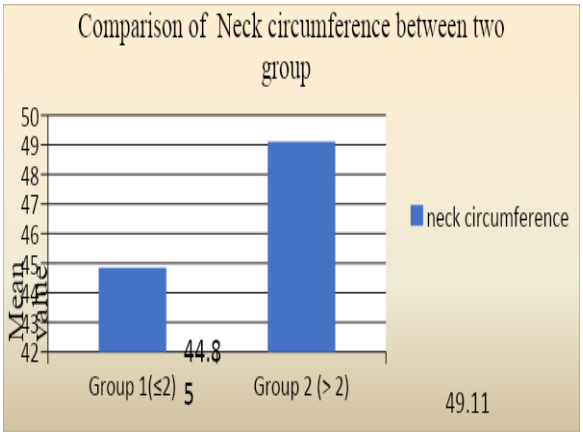

Figure 2

TABLE 2

	Group 1 (CL≤2) (n=51)	Group 2 (CL>2) (n=19)	p value
	frequency	frequency	
MPG I	9	2	
II	30	5	0.008
III	12	12	
TMD<6cm	7	7	0.032
Sex (M/F)	31/20	14/5	0.471
OSA (Y/N)	20/31	9/10	0.538

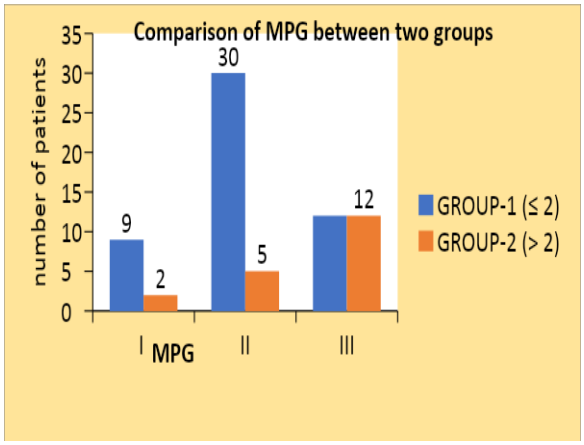

Figure 3

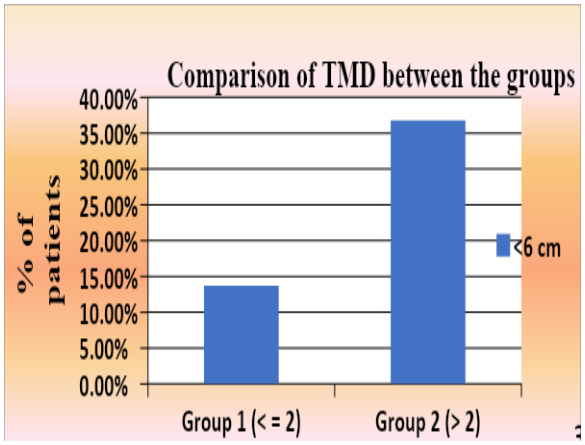

Figure 4

TABLE 3: Independent predictors for difficult laryngoscopy using multivariable analysis

	Odds ratio	95% C.I. for EXP (B)		p value
		Lower	Upper	
Age	0.97	0.92	1.02	0.288
Gender	2.78	0.59	13.07	0.195
BMI	1.01	0.91	1.12	0.788
OSA	1.18	0.31	4.46	0.805
Mouth opening	0.29	0.06	1.44	0.130
NC	0.46	0.09	2.32	0.346
TMD group	6.93	1.17	41.09	0.033*
MPG (I Vs. III)	2.38	0.30	18.86	0.410
MPG (II Vs. III)	0.49	0.06	3.95	0.506
USG soft tissue thickness (Average)	0.63	0.27	1.46	0.281

**Statistical significant*

DISCUSSION

In our study 41 patients have easy and 19 have difficult laryngoscopy and none of the patients had CL grading 4, 19 patients had CL grading 3 and 41 patients had CL grading ≤ 2. Both the groups were comparable in respect to age, weight, height, gender, ASA class and co-morbidities. Although Patient with H/O sleep apnea have high incidence of airway obstruction and difficult airway, in our study 41.4% patients had sleep apnea but

there was no difference in laryngoscopy assessment (p-value 0.538). Similar results were found by Nelingan J Patrick et al [10] and contrast results were found by Komastu R et al [8]. The difference in results in this study might be due to differences in patient population. They included patients who were a diagnosed cases of OSA (by Polysomnography) while in our study not all patient had H/O sleep apnea and Polysomnography was not performed. Although morbid obesity is associated with difficult laryngoscopy and intubation, in our study obesity (BMI 43.82 ± 8.23) was not a significant predictor (p-value 0.328) this is supported by numerous studies as Ezri et al [7], they had done a study in 200 obese and 1272 non obese patients and they found that laryngoscopy grading was not being affected by high BMI score (p-value 0.56). Fox WT et al [11] had conducted a similar study in 190 obese patients undergoing bariatric surgery and did not find any statistical significance difference between laryngoscopy grading and BMI (p-value 0.6271). Similar result was also found by Brodsky et al [6]. We studied the ease of laryngoscopy in patients with less mouth opening, which was statistical insignificant (p-value = 0.059). Similar results were seen by Ezri et al [7] and Komastu R et al [8]. Mallampati scoring is a good clinical predictor as the MPG increased, difficulty of laryngoscopy increases this is supported by Nelingan J. Patrick et al [10] who found that MPG class III or IV was associated with difficult intubation in contrast to Ezri T et al [7], Komastu R et al [8] and Lee et al [12], this may be due to difference in patient populations and inter-observer variability.

TMD helps in determining the ability of laryngeal axis to fall in line with the pharyngeal axis when the atlanto-occipital joint is extended [13]. In our study, 14 out of 70 patients with TMD <6 cm were found to have difficult laryngoscopy (p-value 0.032). Similar results were also found by Patil et al [13]. Neck circumference measurement at the level of thyroid cartilage greater than 43 cm associated with difficult laryngoscopy according to Gonzalez et al [14]. In our study 46 patients had NC > 43 cm, out of which 16 patients had difficult laryngoscopy. The average NC in cases of difficult laryngoscopy was 49.11 ± 4.58 cm and was found to be statistical significant when compared to average NC in patients with easy laryngoscopy (44.85 ± 4.71 cm) (p value = 0.047).

In addition to bedside parameters of airway assessment, we used ultrasound to assess the airway due to its noninvasive and safe tool for diagnosis and assessment of airway with high accuracy.

We assessed anterior neck soft tissue thickness at the level of vocal cord by USG, which is similar to a study done by Komastu R et al [8]. Same study done by Ezri T et al [7], they had measured anterior neck soft tissue thickness at three levels vocal cord, thyroid isthmus and suprasternal notch. In our study the average soft tissue thickness in group 1 was 18.3±1.1 and in group 2 it was 18.6±0.9. Out of 19 patients who had difficult laryngoscopy, maximum soft tissue thickness at central axis was 17.37 mm, at 15 mm right and 15 mm left it was 22.63 mm and 23.25 mm respectively. But the difference was not statistical significant (p-value 0.317). The study by Komastu R et al [8] also measured thickness at the same level and they found contrastingly less thickness in group 2 (20.4±3.0) than group 1 (22.3±3.8) and found negligible statistical significance (p-value 0.049). In Contrast Ezri T et al [7] found significant difference at the level of vocal cord (p-value <0.001) and at suprasternal notch level (p-value 0.013).

The difference in results could be due to difference in patient population. In our study only Indian patients were included, Ezri T et al [7] included all Middle Eastern patients while Komastu R et al [8] studied all Caucasians patients. There are recognized differences in fat distribution between various groups [15,16].

A multivariate logistic regression with a laryngoscopy grade of 3 or 4 as the endpoint indicated that TMD is the only independent predictor for difficulty

laryngoscopy. None of the other factors are when used solely are good predictor.

CONCLUSION

To conclude USG assessment of anterior neck soft tissue thickness at the level of vocal cord is not a good predictor of difficult laryngoscopy in obese patients. Among the potential predictors of difficult laryngoscopy MPG, TMD and neck circumference were the only measures that fully distinguished difficult laryngoscopy from easy one in the present subset of patients.

Declaration of Patient Consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of Interest: There are no conflicts of interest in our study.

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How to cite this article: Kesarwani D, Chandrakar N, Bano R et.al. Ultrasound assessment of anterior neck soft tissue thickness as a predictor of difficult laryngoscopy and intubation in obese patients. *International Journal of Research and Review*. 2021; 8(1): 716-722.

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