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Ultrasound Guided Airway Parameters for Predicting Difficult Mask Ventilation: A Prospective Observational Study

Zor Maske Ventilasyonunun Öngörülmesinde Ultrason Kılavuzluğunda Hava Yolu Parametreleri: Prospektif Gözlemsel Bir Çalışma

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ABSTRACT

Objective: Face mask ventilation is the method of ventilation in all patients before securing definitive airway. Airway examinations are based on history and physical examinations to predict difficult mask ventilation (DMV) or laryngoscopy. Ultrasound being rapid bed side tool has gained popularity in airway management, point of care ultrasound can be used as a clinical tool for evaluating airways. We attempted to assess the correlation between difficult mask ventilation and ultrasound assessment of distance between lingual arteries (DLA), tongue thickness (TT) and lateral pharyngeal wall thickness (LPWT) after standard induction of anaesthesia.

Method: Overall, 264 patients scheduled for elective surgery requiring general anaesthesia were included. In preoperative holding area, ultrasonographic assessment of DLA, TT and LPWT were measured. After standard induction, mask ventilation is attempted and graded according to Han's grading. Mask ventilation was considered as difficult for Han's grade 2 and above.

Results: Out of 264 patients, 230 (87.1%) had easy mask ventilation, while 34 (12.9%) experienced difficult mask ventilation. Pre induction values of DLA more than 2.52 cm had sensitivity of 47.06%, specificity of 76.09% with area under receiver operating characteristics (AUROC) of 0.641 and P value 0.004. Tongue thickness more than 4.67 cm had sensitivity of 44.12%, specificity of 83.04% with AUROC of 0.636 and P value <0.001. Both DLA and TT were predictive of DMV with DLA has better prediction DMV than TT.

Conclusion: Distance between lingual arteries more than 2.52 cm and TT more than 4.67 cm are predictive of DMV.

Keywords: Difficult mask ventilation, distance between lingual arteries, lateral pharyngeal wall thickness, tongue thickness, ultrasound, point of care ultrasound

ÖZ

Amaç: Yüz maskesi ventilasyonu, kesin hava yolunu sağlamadan önce tüm hastalarda ventilasyon yöntemidir. Hava yolu muayeneleri, zor maske ventilasyonunu (ZMV) veya laringoskopiyi tahmin etmek için öykü ve fiziksel muayenelere dayanır. Ultrasonun hızlı ve yatak başında uygulanabilen bir araç olması, havayolu yönetiminde giderek daha fazla popülerlik kazanmasına yol açmıştır; hasta başı ultrasonografi, havayolunun değerlendirilmesinde klinik bir araç olarak kullanılabilmektedir. Standart anestezi indüksiyonu sonrasında, ZMV ile ultrasonografik olarak ölçülen lingual arterler arası mesafe (LAM), dil kalınlığı (DK) ve lateral farengeal duvar kalınlığı (LFDK) arasındaki ilişkiyi değerlendirmeyi amaçladık.

Yöntem: Genel anestezi gerektiren elektif cerrahi için planlanan 264 hasta dahil edildi. Ameliyat öncesi bekleme alanında, LAM, DK ve LFDK'nin ultrasonografik değerlendirmesi ölçüldü. Standart indüksiyon sonrasında maske ventilasyonu uygulandı ve Han sınıflamasına göre derecelendirildi. Han sınıflamasına göre derecesi 2 ve üzeri olan maske ventilasyonu, zor olarak kabul edildi.

Bulgular: Toplam 264 hastanın 230'unda (%87,1) maske ventilasyonu kolay iken, 34 hastada (%12,9) ZMV gözlendi. İndüksiyon öncesi LAM değerinin 2,52 cm'nin üzerinde olması %47,06 duyarlılık ve %76,09 özgüllük göstermiş olup, alıcı operatör karakteristiği altında kalan alan (AUROC) değeri 0,641 ve p değeri 0,004 olarak saptandı. Dil kalınlığı değerinin 4,67 cm'nin üzerinde olması ise %44,12 duyarlılık ve %83,04 özgüllük ile AUROC 0,636 ve p<0,001 olarak bulundu. Hem LAM hem de DK, ZMV için öngördürücü olup, LAM'ın öngörü gücü DK'ye kıyasla daha yüksekti.

Sonuç: Lingual arterler arasındaki mesafenin 2,52 cm'nin üzerinde olması ve DK'nin 4,67 cm'nin üzerinde olması, ZMV için prediktiftir.

Anahtar sözcükler: Zor maske ventilasyonu, lingual arterler arası mesafe, lateral faringeal duvar kalınlığı, dil kalınlığı, ultrasonografi, hasta başı ultrasonografi

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INTRODUCTION

Anesthesiologists must ensure unobstructed airways for optimal oxygenation and ventilation throughout their airway management strategy. Face mask ventilation is a non-invasive airway management technique that preserves upper airway patency with minimal equipment and methods. The dynamic upper airway may experience obstruction at several anatomic locations, from the larynx to the nasal cavities (1). Two of the three areas—the base of the tongue and the epiglottis (the third being the glottis), where obstructions to oral ventilation may occur—respond effectively to external manoeuvres. When endotracheal intubation is unsuccessful and supraglottic device placement is inadequate or fails, facemask ventilation remains the sole rescue method to oxygenate and ventilate the patient. If the face mask ventilation fails, the patient deteriorates into a cannot intubate, cannot oxygenate situation, resulting in morbidity and mortality. Of anesthesia-related fatal outcomes, inadequate mask ventilation or a failure to intubate accounts for 28% (2).

Difficult mask ventilation (DMV) refers to the failure to establish a sufficient seal between the mask and the face and the inability to maintain a patent airway. In the general adult population, the incidence of DMV is 5%, while the incidence of impossible ventilation varies from 0.15 to 0.16% (3-5). The 2022 practice guidelines from the American Society of Anaesthesiologists define DMV as "impossible to provide adequate ventilation (e.g., confirmed by end-tidal carbon dioxide detection) because of one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas" (6). Difficulty in mask ventilation is graded by the Hans Grading scale (7).

The predictors of DMV include the presence of a beard, obesity (increased body mass index (BMI)), a history of obstructive sleep apnea, age >55 years, male gender and edentulous patients (3,8). The correlation between obstructive sleep apnoea (OSA) and DMV has been substantiated in numerous studies (4,9). Recent studies have found a positive correlation between OSA and lateral pharyngeal wall thickness (LPWT), while a history of OSA serves as an independent predictor of DMV (10-12).

Ultrasound plays a swift bedside role in airway management, including identification of proper endotracheal tube placement, difficult airway prediction, percutaneous dilatational tracheostomy, determination of double lumen tube size, calculation of paediatric endotracheal tube size, identification of subglottic stenosis, prediction of post-extubation stridor, and performing cricothyroidotomy (13-26).

Research has demonstrated that propofol administration induces anatomical changes in the airway parameters: distance between lingual arteries (DLA), LPWT and tongue thickness (TT) (27). Although research has demonstrated a correlation between OSA and difficult airways, it is uncertain if the TT, DLA, and LPWT measured by submental ultrasound are reliable indicators for the prediction of DMV. In our novel study, we hypothesised that DLA, TT and LPWT changes post-induction and hence we aimed to evaluate the relationship between DMV and ultrasound assessment of the three parameters – DLA, TT, LPWT after standard anesthetic induction.

SAMPLE SIZE

Sample size was calculated assuming the difference of diagnostic accuracy of lateral pharyngeal wall pre and post operatively using area under the ROC curve (AUC). The AUC of lateral pharyngeal wall in predicting DMV pre-operatively was considered as 0.67 as per the reference study by Mehta et al. and assuming 1 unit difference post operatively in AUC (12). The other parameters considered for sample size calculation were 90% power of study, two-sided alpha error of 0.05. Approximate proportion of outcome negative and positive groups was considered as 2:1. Sample size was calculated using RStudio statistical software after feeding the above-mentioned parameters (28). The required sample size as per the above-mentioned calculation was 240. To account for a loss to follow up of about 10% another 24 subjects will be sampled. Hence the final required sample size was taken as 264. Similarly, sample size calculated using DLA and TT revealed requirements of 174 and 198 samples respectively as per our pilot studies, as there was no related research regarding these measurements. Since sample size needed for LPWT was found to be larger, so that we did the study, we did the study with 264 samples for all parameters.

MATERIAL and METHODS

The study was conducted in tertiary care university teaching hospitals after obtaining institutional ethics committee approval (CSP-MED/23/MAR/85/71). After written informed consent to participate in the study, 264 eligible patients, of age 18 - 75 years, undergoing elective surgery under general anesthesia requiring mask ventilation were included. Patients with anticipated difficult airways needing elective tracheostomy, expected difficult laryngoscopy, indications for awake fiber-optic intubation, facial abnormalities, facial oedema, facial wounds or dressings, undergoing elective tracheostomies, a history of oral-maxillofacial surgeries, parturient, those requiring rapid sequence induction, emergency surgeries, patient refusals and those unable to provide consent were excluded from the study.

A detailed pre-anesthetic evaluation with demographic parameters of age, gender, weight, height and BMI along with

the following information were recorded - dentition, mouth opening, Mallampatti grading, presence of beard, STOP BANG score, neck circumference, neck movements, thyro-mental distance (measured from the bony point of the mentum (chin) to the notch of the thyroid cartilage with the patient lying supine, mouth closed, and head fully extended) and sterno-mental distance (the patient seated with their head in full extension and mouth closed and a ruler is used to measure the straight distance from the upper border of the sternum's manubrium to the bony point of the mentum (chin)). In the pre-operative holding area, ultrasonographic assessment was done by an experienced anesthesiologist in airway ultrasound, with patient in 'sniffing the morning air position' like the position of mask ventilation, without any pressure on the probe to clearly visualise vascular structures. Ultrasound measurements were taken with the Sonosite Edge II ultrasound machine (Fujifilm SonoSite, Inc.; Bothell, WA, USA) by the same observer to rule out inter-observer variability. The DLA was measured using a linear ultrasound probe. The transducer was positioned in the submandibular plane at the midpoint of the inferior border of the mandible and the hyoid (Figure 1). Tongue thickness was measured using a curvilinear ultrasound probe with the transducer placed in the sagittal plane at midline position in the submandibular space (Figure 2). Lateral pharyngeal wall thickness was measured using the linear ultrasound probe, and the transducer is placed below the level of the mastoid process in the coronal plane to measure LPWT between the inferior border of the internal carotid artery and the lateral pharyngeal wall (Figure 3).

After the patient was wheeled inside the operation theatre, baseline monitors – non-invasive blood pressure, electrocardiogram and pulse oximetry – were connected. Patients were pre-oxygenated for 5 minutes with 100% oxygen and induced with intravenous fentanyl 2 μg kg^{-1} and intravenous propofol 2 mg kg^{-1}. After inducing anesthesia, before administration of neuromuscular blocking drug, mask ventilation was done by another experienced anesthesiologist, blinded to the ultrasound findings, with patient in sniffing the morning air position. The difficulty of mask ventilation was assessed and graded using Han's DMV Grading (7). Mask ventilation was considered difficult for Han's grade 2 and above.

Statistical Analysis

Descriptive analysis was carried out by frequency and proportion for categorical variables. Continuous variables were presented as mean ± Standard Deviation (SD). Shapiro wilk test was used to perform normality tests for continuous variables. The chi-square test was used to test the statistical significance of cross-tabulation between categorical variables. A

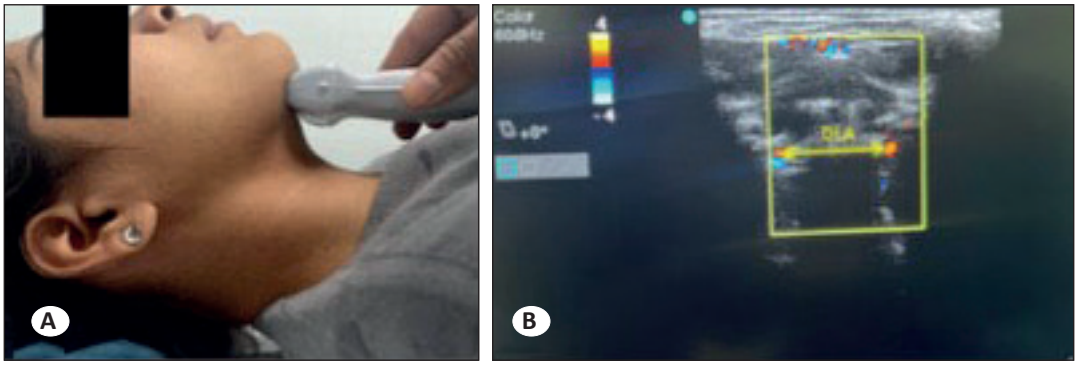

Figure 1. A) Transducer position to measure distance between lingual arteries. **B)** Ultrasound image to measure distance between lingual arteries.

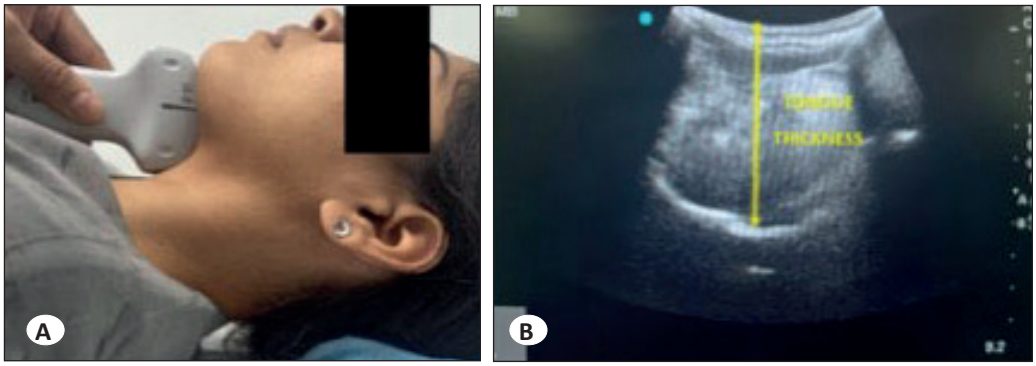

Figure 2. A) Transducer position to measure tongue thickness. **B)** Ultrasound image to measure tongue thickness.

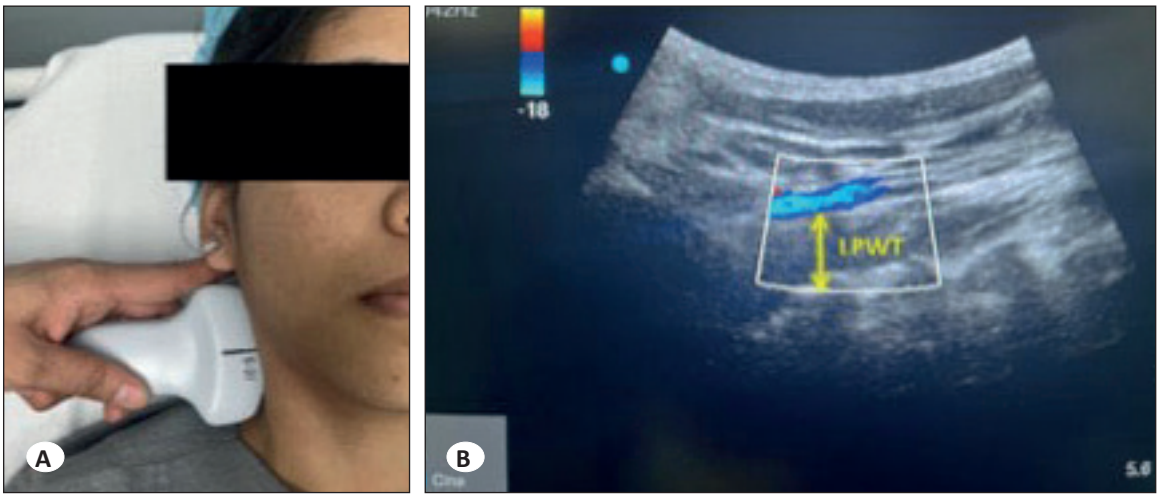

Figure 3. A) Transducer position to measure lateral pharyngeal wall thickness (LPWT). **B)** Ultrasound image to measure lateral pharyngeal wall thickness (LPWT).

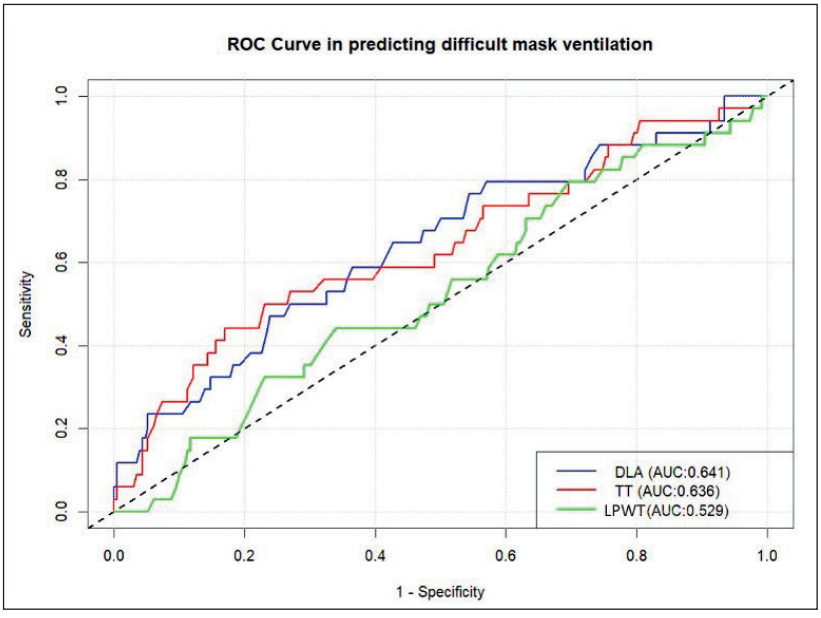

Figure 4. Receiver Operating Characteristics Curve (ROC) in predicting difficult mask ventilation. **DLA:** Distance between lingual arteries; **TT:** Tongue thickness; **LPWT:** Lateral pharyngeal wall thickness.

paired sample t-test was used to compare the mean ± SD of continuous variables within the groups. The ROC analysis was used to assess the performance of DLA, LPWT and TT as a predictor of DMV. The sensitivity, specificity, positive and negative predictive values and overall diagnostic accuracy of the parameters are presented. p value < 0.05 was considered statistically significant. Univariate and multivariate binary logistic regression were done to assess the factors associated with difficult ventilation. R-Studio Desktop Version 2023.03.0+ 386 was used for statistical analysis (28).

Table I. Han's Difficult Mask Ventilation Grading

Grade	Ease of mask ventilation
0	Ventilation by mask not attempted
1	Ventilated by mask
2	Ventilated by mask with oral airway or other adjuvants
3	Difficult mask ventilation inadequate, unstable or requiring two practitioners
4	Unable to mask ventilate

RESULTS

A total of 264 patients were included in the study. The mean age of the study population was 44.27 with a 95% CI (42.51, 46.04). The BMI was 26.83 with a 95% CI (26.23, 27.42). The descriptive analyses of parameters in the study population are mentioned in Table II. Shapiro wilk test showed a mild departure from normality for LPWT(Test statistic W-0.932) and TT (W-0.9804) while the magnitude of difference between the sample distribution and the normal distributions is very small for DLA (W-0.99), and all of them are statistically insignificant ($p<0.05$).

Most patients - 230 (87.1%), were easy to mask ventilate of Han's grade 1. Twenty-seven patients (10.2%) required an oral airway or other adjuvant and were marked as difficult to mask ventilate with Han's grade 2. Six patients (2.3%) required two providers and were very difficult to mask ventilate with Han's grade 3. One patient was classified as Han's grade 4 and was unable to be mask-ventilated (0.4%). We classified patients graded 2 and above as difficult to mask ventilate. We classified 230 (87.1%) of the 264 patients as having easy mask ventilation and the remaining 34 (12.9%) as having DMV.

Among patients with a BMI greater than 35, 11 out of 13 (84.6%) had easy mask ventilation, and 2 out of 13 (15.4%) had DMV. Of the 55 patients with an Mallampatti grade of 3 or 4, 45 (81.8%) had easy mask ventilation, and 10 (18.2%) had difficult mask ventilation. Of the 189 patients with a STOP-BANG score less than 2, 176 (93.1%) had easy mask ventilation, and 13 (6.9%) had DMV. There were 75 patients with a STOP BANG score greater than 2, of which 54 (72%) had easy mask ventilation, and 21 (28%) had DMV. Among the 106 patients with a positive history of snoring, 81 (76.4%) had easy mask ventilation, and 25 (23.6%) had DMV. Out of 22 patients with a neck circumference greater than 40 cm, 16

Table II. Descriptive Analysis of Parameters in the Study Population (n=264)

Parameter	Mean ± Standard Deviation	Median	Minimum	Maximum	95% Confidence Interval	
					Lower	Upper
Age, years	44.27 ± 14.57	44.00	18.00	75.00	42.51	46.04
Weight, kg	70.3 ± 13.59	70.00	39.00	135.00	68.66	71.95
Height, cm	161.96 ± 9.63	162.00	140.00	190.00	160.79	163.13
Body mass index, kg m^{-2}	26.83 ± 4.9	26.65	16.82	55.47	26.23	27.42
Neck circumference, cm	35.76 ± 2.87	35.00	30.00	47.00	35.41	36.11
Thyromental, cm	9.39 ± 1.12	9.00	7.00	13.00	9.26	9.53
Sternomental, cm	16.65 ± 1.43	17.00	13.00	21.00	16.48	16.82

Table III. Descriptive Analysis of Han's Grading for Mask Ventilation in the Study Population (n=264)

Han's Mask Ventilation Grade		Frequency	Percentages (%)
Easy mask ventilation	1	230	87.1
Difficult mask ventilation requiring an oral airway or other adjuvants	2	27	10.2
Very difficult mask ventilation requiring two providers	3	6	2.3
Unable to mask ventilate	4	1	0.4

Table IV. Descriptive Analysis of Ease of Mask Ventilation Based on Different Subgroups

Parameters (Total)	Mask Ventilation, n (%)		p-value
	Easy	Difficult	
Overall population (n=264)	230 (87.1)	34 (12.9)	**<0.001**
Body Mass Index >35 kg m^{-2}	11 (84.6)	2 (15.4)	0.673
Mallampatti Grade 3 and 4	45 (81.8)	10 (18.2)	0.19
STOP BANG score 0-2	176 (93.1)	13 (6.9)	0.769
STOP BANG score >2	54 (72)	21 (28)	**<0.001**
Snoring (Positive)	81 (76.4)	25 (23.6)	**<0.001**
Neck circumference >40 cm	16 (72.7)	6 (27.3)	0.05
Age >55 years	49 (76.6)	15 (23.4)	**0.013**

DMV: Difficult mask ventilation.

Table V. Diagnostic Accuracy test of Pre-Induction Ultrasound Measurements of DLA, TT and LPWT in Predicting Difficult Mask Ventilation

Parameter	Distance between lingual artery			Tongue thickness			Lateral pharyngeal wall thickness		
	Value	95% Confidence interval		Value	95% Confidence interval		Value	95% Confidence interval	
		Lower	Upper		Lower	Upper		Lower	Upper
Cut off point, cm	≥2.52			≥4.67			≤1.03		
Sensitivity, %	47.06	29.78	64.87	44.12	27.19	62.11	44.12	27.19	62.11
Specificity, %	76.09	70.04	81.45	83.04	77.56	87.66	66.09	59.57	72.18
False positive rate, %	23.91	18.55	29.96	16.96	12.34	22.44	33.91	27.82	40.43
False negative rate, %	52.94	35.13	70.22	55.88	37.89	72.81	55.88	37.89	72.81
Positive predictive value, %	22.54	13.46	34.00	27.78	16.46	41.64	16.13	9.32	25.20
Negative predictive value, %	90.67	85.66	94.38	90.95	86.23	94.46	88.89	83.19	93.18
Diagnostic accuracy, %	72.35	66.53	77.66	78.03	72.55	82.87	63.26	57.13	69.08
Positive likelihood ratio	1.97	0.71	2.724	2.60	0.74	3.527	1.30	0.52	1.778
Negative likelihood ratio	0.70	0.13	0.963	0.67	0.17	0.912	0.85	0.11	1.156
Area under receiver operating characteristics curve (AUROC)	0.641	0.536	0.746	0.636	0.527	0.745	0.529	0.425	0.633
p value	**0.004**			**<0.001**			0.245		

DLA: Distance between lingual artery, **TT:** Tongue thickness, **LPWT:** Lateral pharyngeal wall thickness.

Table VI. Univariate and Multivariable Binary Logistic Regression to Assess the Factors Associated with Difficult Ventilation

Variables (Pre induction)	Univariate analysis		Multivariable analysis	
	Unadjusted Odds Ratio (95% Confidence interval)	p-value	Adjusted Odds Ratio (95% Confidence Interval)	p-value
Distance between lingual artery, cm	3.27 (1.39-7.69)	**0.007**	2.88 (1.22-6.80)	**0.016**
Tongue thickness, cm	1.88 (1.15-3.05)	**0.011**	1.72 (1.06-2.80)	**0.028**
Lateral pharyngeal wall thickness, cm	0.98 (0.48-2.00)	0.953	-	-

(72.7%) had easy mask ventilation, and 6 (27.3%) had DMV. Among the 64 patients older than 55 years, 49 (76.6%) had easy mask ventilation, and 15 (23.4%) had DMV.

In our study population, DLA ≥ 2.52 cm had a sensitivity of 47.06% and specificity of 76.09%, positive predictive value (PPV) of 22.54% and negative predictive value (NPV) of 90.67% in predicting DMV. Furthermore, TT ≥ 4.67cm had a sensitivity of 44.12% and specificity of 83.04%, PPV of 27.78% and NPV of 90.95% in predicting DMV. Lateral pharyngeal wall thickness ≤ 1.03 cm had a sensitivity of 44.12% and specificity of 66.09%, PPV of 16.13% and NPV of 88.89 in predicting DMV. In ROC predicting difficult mask ventilation, DLA has AUROC 0.641, TT has AUROC 0.636, and LPWT has AUROC 0.529, with statistical significance for DLA (P value 0.004) and TT (P value <0.001). The DLA and TT was found to be a significant predictor of DMV in univariate analysis. In multivariable analysis, for every one-unit increase in DLA, there was 2.88 times (adjusted OR: 2.88; 95% CI: 1.22 to 6.80) higher probability of DMV. For every one-unit increase in TT, there were 1.72 times (adjusted OR: 1.72; 95% CI: 1.06 to 2.80) a higher probability of DMV, which is statistically significant.

DISCUSSION

Face mask ventilation is an essential and basic skill in the maintenance of the airway, and it is the method of ventilation in all patients before securing a definitive airway or any airway device. It is one of the vital modalities to maintain a patent airway, along with endotracheal intubation and supraglottic device placement, and hence its importance in all difficult airway algorithms as the rescue technique in case of failed or difficult intubation scenarios. It is also the rescue method to oxygenate and ventilate when there is a failure to secure a supraglottic device or intubate the patient (6,29, 30). The incidence of severe hypoxaemia is reduced in critically ill patients with effective face mask ventilation prior to intubation (31). Inadequate or DMV occurs due to inadequate seal between

face and mask, error in technique or partial or complete upper airway obstruction. If difficulty in ventilation arises after anesthetic induction, the airway posture should be adjusted, and various airway manoeuvres, such as head tilt, chin lift, jaw thrust, or use of airway adjuncts like oropharyngeal or nasopharyngeal airways, by use of two-handed triple airway manoeuvre with oropharyngeal airway and pressure-controlled ventilation, can be used (32,33). Obstruction can also be relieved by the usage of an oral or nasopharyngeal airway or by using a two-hand and two-practitioner technique. Despite all these rescue techniques, there is a possible scenario of inability to mask ventilate which is fatal.

Difficulty in mask ventilation is graded by the Hans Grading scale (7). There are numerous preoperative clinical airway assessment parameters that have been researched to predict difficult mask ventilation (3-5). We attempted to predict difficult mask ventilation by conducting this novel study using upper airway ultrasound-guided measurements - DLA, TT and LPWT. This prospective observational study on 264 adult patients requiring general anesthesia was done to predict DMV at our tertiary care teaching university hospitals.

The incidence of DMV from our study was 12.9%, and impossible mask ventilation was 0.4%. This incidence is less when compared to the study by Kheterpal et al., with DMV of 22.66% and impossible to ventilate incidence of 0.16% (after equating for DMV when Han's Mask ventilation grade is 2 and above in both studies) (4).

In our study, we have found that the DLA ≥ 2.52 cm (p-value 0.004) and TT ≥ 4.67 cm (p-value < 0.001) has statistical significance in predicting DMV. With sensitivity and specificity for DLA (47.06% and 76.09%) and TT (44.1% and 83%), respectively. This is in accordance with studies conducted by Lin et al., Bianchini et al., and Yao et al. (34-36). Lin et al. found that the DLA and TT increases after induction (predictive if more than 6.96 cm), while Bianchini et al. found that TT of more than 5 cm predicted a DMV, which is comparable to our study (34,35).

Distance between lingual arteries shows moderate specificity (76.09%) and diagnostic accuracy (72.35%). The sensitivity (47.06%) is relatively low. With an AUROC of 0.641 (p-value 0.004), TT has higher specificity (83.04%), and diagnostic accuracy (78.03%) compared to DLA and sensitivity (44.12%). An AUROC of 0.636 for TT (P value <0.001). Lateral pharyngeal wall thickness exhibits the lowest specificity (66.09%) and diagnostic accuracy (63.26%). Sensitivity (44.12%) is comparable to DLA and TT. The AUROC of 0.529 (P value 0.245) indicates poor diagnostic ability and has a higher false positive rate (33.91%). This is in accordance with the previous studies conducted by Lin et al., Bianchini et al., and Nakazawa et al. (34,35,37).

Limitations

The limitations of our study include the need for advanced training in ultrasound for reproducibility in clinical practice. A multi-centric study done by different expert sonologists will further open more results and research avenues that will give more robust evidence for clinical practice. Since the study population is from a university teaching hospitals that caters to different population subsets from across the country, it may not be applicable for ethnicities from other countries which can explain that Lin et al had a DMV with TT > 6.96 cm while we had DMV when TT > 4.67 cm (34). More importantly, there is paucity of literature on ultrasound predictors of DMV. Hence, we used conventional DMV parameters to find the predictability of difficulty in mask ventilation to associate with ultrasound airway parameters like DLA, TT, and LPWT. From our novel study, the DLA and TT statistically predicts DMV. So, they were used to predict DMV among various subgroups, and we found a statistically significance with STOP BANG >2, snoring and age > 55 (p<0.05). Further research in this area with subset populations, such as obesity, and higher STOP-BANG scores in a greater number of populations in different centres, difficulty in mask ventilation after neuromuscular blockade etc., will throw more light on the pre-operative utility of ultrasound parameters in predicting DMV. Since most difficult airway predictors are poorly sensitive when used as standalone predictors, we suggest the combined use of DLA and TT to predict DMV. Adding on to the classical clinical parameters for DMV, ultrasound parameters of DLA and TT will add to successful prediction of DMV.

CONCLUSION

In our prospective observational study, we found that ultrasound parameters - DLA > 2.52 cm and TT > 4.67 cm, predict DMV with an independent association and can be used clinically as an armamentarium to predict DMV.

AUTHOR CONTRIBUTIONS

Conception or design of the work: SGR, GB
Data collection: GB, SGR
Data analysis and interpretation: GB, SGR
Drafting the article: GB, SGR
Critical revision of the article: SGR, AP
The author (SGR, AP) reviewed the results and approved the final version of the manuscript.

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