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Predictive value of Thyromental height test (TMHT) , USG airway (ANS-VC) and Modified Mallampati test (MMT) for Difficult Airway : A Comparative Study

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Abstract

Introduction : Securing the airway for providing adequate oxygenation and ventilation is crucial in patients undergoing surgery requiring general anesthesia. The Modified Mallampati test has been traditionally used to predict difficult airway. The Thyromental Height test (TMHT) is an easy-to-do and non-invasive test. Increased anterior neck soft tissue thickness can impair the forward mobility of pharyngeal structures resulting in difficult laryngoscopy and intubation. Therefore we conducted this study to evaluate the predictive value of Thyromental height test (TMHT), Ultrasound guided anterior neck soft tissue thickness at the level of vocal cords (ANS-VC)and Modified Mallampatti test (MMT) in predicting difficult airway.

Methodology : This prospective comparative study was done in a tertiary care hospital in India . Ethical committee approval and written informed consent was taken for the present study. 252 patients of either sex, age > 18 yrs, ASA I-II, who required general anaesthesia with endotracheal intubation for elective surgery were included in the study. Patients with malformation of the upper airway, pregnant women , patients coming for Emergency surgeries and patients who need awake intubation were excluded from the study. Preoperative airway assessment (TMHT, ANS -VC , MMT) of all the patients was done by the same anaesthesiologist to avoid observer variability. All the patients were induced by a standard protocol. During laryngoscopy the cormack lehane grading was noted.

Results: Preoperative airway evaluation parameters studied were modified mallampatti grading (MMT) , thyromental height test (TMHT) and ultrasound guided anterior neck soft tissue thickness at the level of vocal cords (ANS-VC). According to MMT predicting difficult airway had a sensitivity of 31.8% and specificity of 91.3%. TMHT showed a sensitivity of 81.82% and specificity of 98.26% whereas ANS-VC showed a sensitivity of 90.91% and specificity of 98.7% in predicting difficult airway .

Hence ANS-VC>0.23cm showed a slightly better predictability of difficult airway preoperatively. TMHT<5.5cm is also an equally good predictor whereas MMT has a very low sensitivity and PPV.

Conclusion : Sonographic parameter ANS-VC >0.23cm is promising in predicting difficult airway. Along with this parameter the clinical parameter TMHT < 5.5 cm is equally good in predicting difficult airway compared to Modified Mallampatti test.

Keywords : Thyromental height test, Modified Mallampati test, Difficult airway, Ultrasonography of airway, Cormack and Lehane grading, anterior neck soft tissue thickness , vocal cords

Introduction

Securing the airway for providing adequate oxygenation and ventilation is crucial in patients undergoing surgery requiring general anesthesia. Difficulties during airway management may cause hypoxemia, aspiration, airway trauma, and even death[1–4]. Difficult intubation, usually defined as a Cormack & Lehane grade III and IV, is relatively common with a reported incidence ranging from 1 to 20% [5–8].

Several risk scores like Mallampatti grading , Wilsons score for prediction of difficult airway have been proposed, but sensitivity is mostly limited and consequently, useful clinical guidance often fails [9].

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The Thyromental Height test (TMHT) is an easy-to-do and non-invasive test. The test is based on the distance between the anterior border of the mentum and the prominent part of thyroid cartilage, while the patient lies supine with the mouth closed [10]. Recent studies reported the TMHT to be more accurate to predict difficult intubation, compared to widely used purely anatomical measurements [10,15].

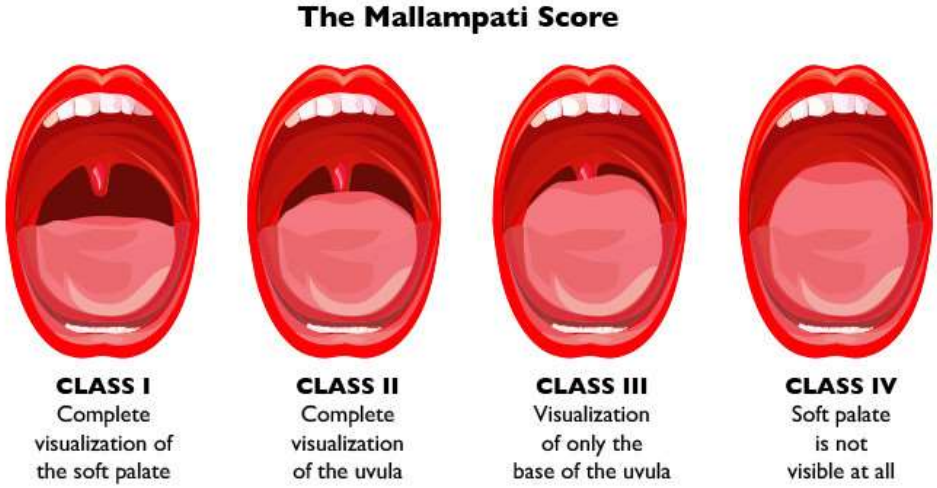
It has been interpreted by many researchers that increased anterior neck soft tissue thickness could impair the forward mobility of pharyngeal structures resulting in difficult laryngoscopy and intubation [16-20]. Ultrasonographic airway assessment could be a useful adjunct, but at present, there are no well-defined sonographic criteria that can predict the possibility of encountering a difficult airway. The ultrasonographic parameters to predict difficult airway are anterior neck soft tissue at the level of hyoid (ANS-Hyoid), anterior neck soft tissue at the level of vocal cords (ANS-VC) and the ratio of the depth of pre-epiglottic space(Pre-E) to the distance from the epiglottis to the midpoint of the vocal cords(E-VC)[21-25]. Therefore we conducted this study to evaluate the predictive value of Thyromental height test (TMHT), usg guided anterior neck soft tissue thickness at the level of vocal cords (ANS-VC) and Modified Mallampatti test (MMT) in predicting difficult airway.

AIMS & OBJECTIVE

To compare the predictive value of thyromental height test (TMHT), Ultrasound guided anterior neck soft tissue thickness at the level of vocal cord (ANS-VC) and Modified Mallampatti test (MMT) for difficult airway in patients undergoing surgery requiring general anesthesia .

MATERIALS AND METHODS

This prospective comparative study was done in a tertiary care hospital in India . After Ethical committee approval and obtaining written informed consent 252 patients of either sex, age >18 yrs, ASA I-II, who required general anaesthesia with endotracheal intubation for elective surgery were included in the study. Patients with malformation of the upper airway, pregnant women , patients coming for Emergency surgeries and patients who need awake intubation were excluded from the study. The study duration was for two years. Preoperative airway assessment of all the patients was done by the same anaesthesiologist to avoid observer variability. The data recorded was for airway assessment as well as demographic data like age, sex, weight, height and body mass index (BMI). The following airway assessment test were done preoperatively. I.MODIFIED MALLAMPATTI TEST(9): The oropharyngeal view was assessed by asking the patient to sit and open his or her mouth maximally and to protrude the tongue without phonation and classified as below:
Class I : hard palate, soft palate, fauces, uvula, anterior and posterior tonsillar pillars visible
Class II: hard palate, soft palate, fauces and uvula visible
Class III: hard palate, soft palate and base of uvula are visible
Class IV: only hard palate is visible



II.THYROMENTAL HEIGHT TEST(TMHT)(10): The height between the anterior border of the thyroid cartilage (on the thyroid notch just between the two thyroid laminae) and the anterior border of the mentum (on the mental protuberance of the mandible) was measured, with the patient lying supine using a pillow with his/her mouth closed. This height will be measured with a depth gauge (Kristeel,1503 DG 1)

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Figure A.Showing measurement of TMHT with a depth gauge (kristeel, 1503 DG 1)

III.USG AIRWAY (25): After positioning the patient supine with head and neck in neutral position, the distance from skin to vocal cords (ANSVC) was measured by placing the linear high-frequency (5-16 MHz) ultrasound probe (Sonosite S-ICUR, Bothell, WA, USA) transversely over the thyroid cartilage. All the measurements were recorded by the anaesthesiologist who was experienced in performing airway ultrasound.

Figure B: Midline Transverse view at the level of vocal cords.

- A-A1 is the anterior neck soft tissue thickness at the level of vocal cords.
- TG – Thyroid gland.
- TC- True vocal cords.
- FC- False vocal cords.

INDUCTION OF ANAESTHESIA:

After confirming the nil per oral status patient was shifted to operation theatre , monitors connected , intravenous fluids were administered. Baseline values of heart rate, blood pressure, oxygen saturation and respiratory rate were recorded. Patient was premedicated with the usual protocol of inj. Glycopyrrolate 0.004mg/kg, Inj. Midazolam 0.02mg/kg, inj. Fentanyl 2mcg/kg . Inj lignocaine 2% (preservative free) was given 1mg/kg to attenuate the pressor response of laryngoscopy. Induction was done with Inj. Propofol 2mg/kg , after the loss of eyelash reflex and doing a check ventilation, patient was paralysed with Inj. Vecuronium 1mg/kg. After ventilating for three minutes intubation was attempted by an anaesthesiologist (experience of 5 yrs) who was blinded to the study.

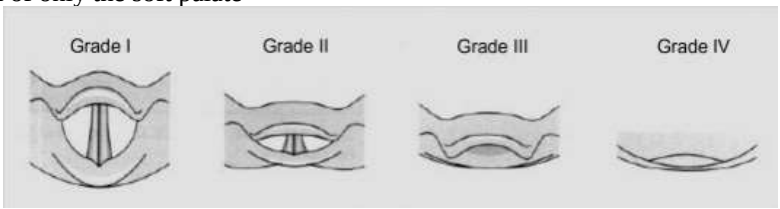
The view of vocal cords on laryngoscopy was graded according to Cormack Lehane Score:

Grade I – visualization of entire laryngeal aperture

Grade II – visualization of parts of the laryngeal aperture or arytenoids

Grade III – visualization of only the epiglottis

Grade IV – visualization of only the soft palate



Adverse effects like bleeding or injury to oral cavity was documented. Intubation was documented as easy, difficult or failed depending on the attempts made to intubate. Any aids like a bougie, videolaryngoscope, stylet used was documented.

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SAMPLE SIZE

Based on the previous studies (6)which had evaluated TMHT to predict difficult airway, the area under the curve was taken to calculate the sample size with alpha error of 0.05. power of study being 80% , calculated sample size was 250. Based on Modified Mallampatti grading reading to predict difficult airway the area under the curve was taken to calculate the sample size with alpha error of 0.5 and power of study being 80%, calculated sample size was 252. Hence taking the attrition into account we took 260 patients as the final sample size.

Statistical Methods: Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean SD (MinMax) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance.

Significant figures

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value:0.01<P 0.05)

** Strongly significant (P value : P0.01)

RESULTS

252 patients were enrolled in the study (males-125, females 127). The demographic variables showed the mean age of the population studied was 39.97±10.58. The mean body mass index was 25.59±2.86(p 0.004) hence showing that higher BMI is associated with a risk of difficult intubation. Using Cormack lehane grading as a guide, 230 patients had CL grade 1,2 easy intubations whereas 22 patients {8.7% - males (8%), females(9.4%)}had CLgrade III and were difficult to intubate. 19 patients were managed with bougie as an aid for intubation and 3 patients required videolarygoscope aided intubation. Preoperative airway evaluation parameters studied were modified mallampatti grading (MMT) , thyromental height test (TMHT) and ultrasound guided anterior neck soft tissue thickness at the level of vocal cords (ANS-VC). According to MMT, 27 patients had difficult intubations but out of these 20 came out to be easy during intubation hence the sensitivity turned out to be 31.8%. the specificity of MMT was 91.3%. there is high interobserver variability which could be a reason for the low sensitivity in our study. Hence the accuracy of MMT is 86.1% with PPV of 25.9 and NPV of 93.3.

TMHT detected 22 patients having difficult intubations out of which 18 turned out to be truly difficult and 4 turned out to be easy. Hence the sensitivity was 81.82% and specificity 98.26%, giving an accuracy of 96%, PPV of 81.8 % and NPV of 98.6%.

ANS-VC predicted 23 patients having difficult intubations preoperatively out of which 20 were difficult and 3 were easy. This test shows a sensitivity of 90.91%, specificity of 98.7%, PPV 86.9%, NPV 99.12 % and accuracy of 98.02%.

As we can see that ANS-VC shows a slightly better predictability of difficult airway preoperatively. TMHT is also an equally good predictor whereas MMT has a very low sensitivity and PPV.

Table 1: Gender- frequency distribution of patients studied

Gender	No. of Patients	%
Female	127	50.4
Male	125	49.6
Total	252	100.0

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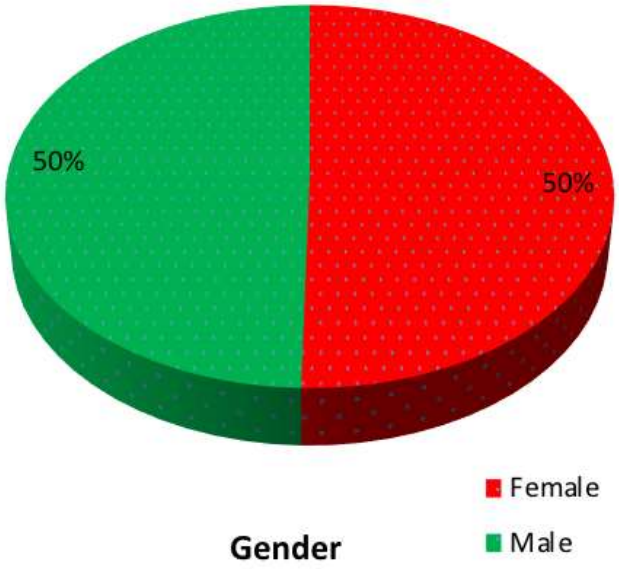

Figure 1

Table 2: Age in years- frequency distribution of patients studied

Age in Years	Gender		Total
	Female	Male	
<20	3(2.4%)	4(3.2%)	7(2.8%)
20-30	24(18.9%)	17(13.6%)	41(16.3%)
31-40	47(37%)	31(24.8%)	78(31%)
41-50	42(33.1%)	41(32.8%)	83(32.9%)
51-60	10(7.9%)	28(22.4%)	38(15.1%)
>60	1(0.8%)	4(3.2%)	5(2%)
Total	127(100%)	125(100%)	252(100%)

P=0.007**, Significant, Fisher Exact Test

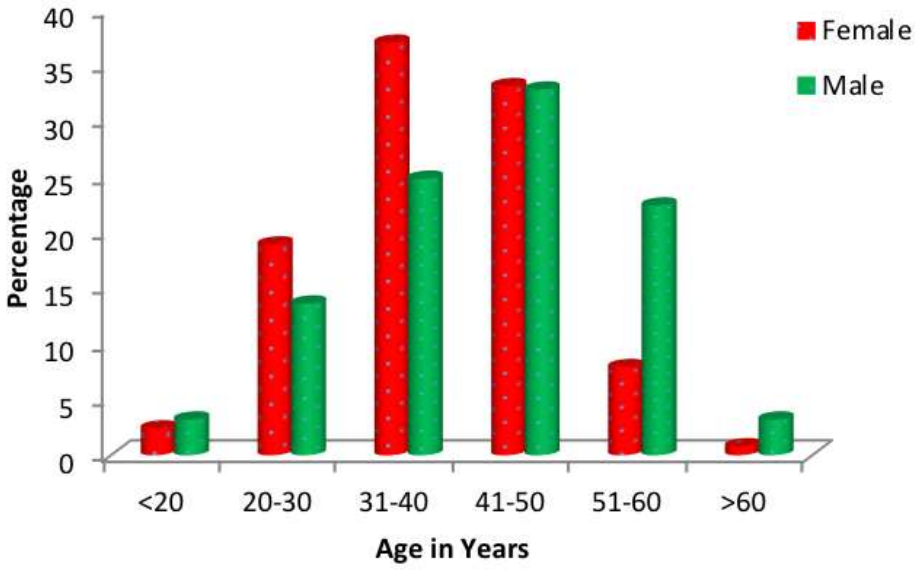

Figure:2

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Table 3: Body Mass Index-BMI-: frequency distribution of patients studied

Body Mass Index	Gender		Total
	Female	Male	
<18.5	0(0%)	0(0%)	0(0%)
18.5-24.9	59(46.5%)	38(30.4%)	97(38.5%)
25.0-29.9	57(44.9%)	78(62.4%)	135(53.6%)
>30.0	11(8.7%)	9(7.2%)	20(7.9%)
Total	127(100%)	125(100%)	252(100%)

P=0.018*, Significant, Chi-Square Test

Figure : 3

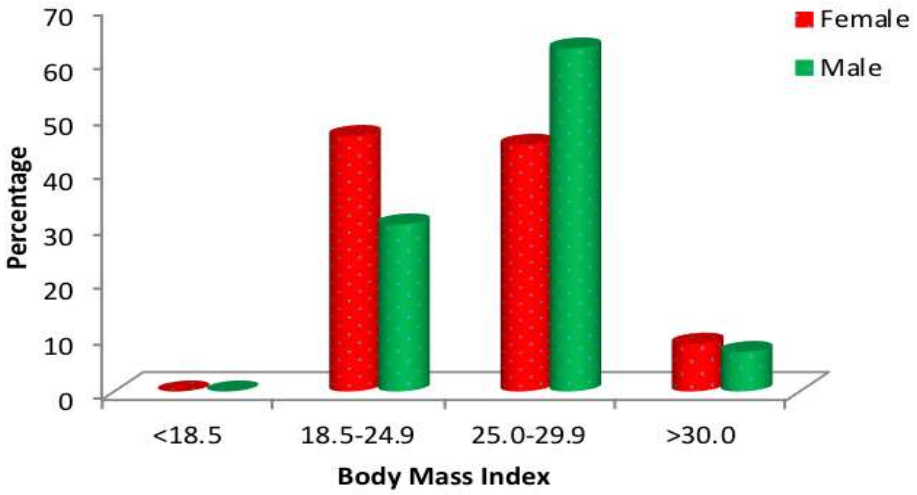

Table 4: MP class - frequency distribution of patients studied

MP	Gender		Total
	Female	Male	
1	33(26%)	38(30.4%)	71(28.2%)
2	85(66.9%)	69(55.2%)	154(61.1%)
3	9(7.1%)	18(14.4%)	27(10.7%)
Total	127(100%)	125(100%)	252(100%)

P=0.082*, Significant, Chi-Square Test

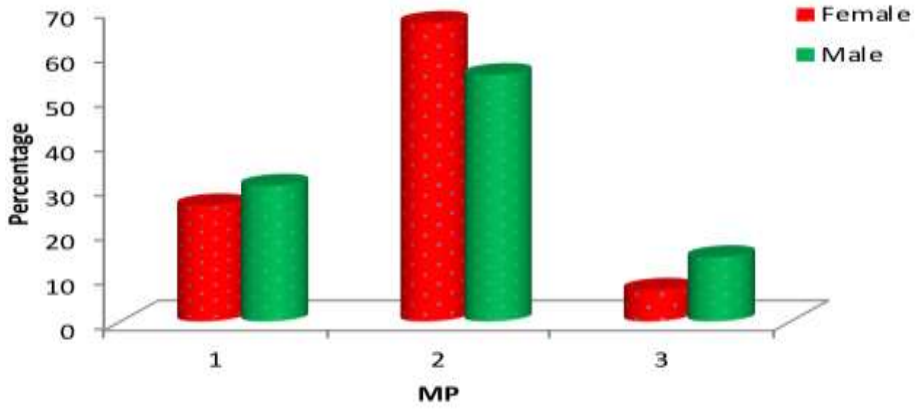

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Table 5: TMHT - frequency distribution of patients studied

TMHT	Gender		Total
	Female	Male	
<5.50	11(8.7%)	11(8.8%)	22(8.7%)
≥5.50	116(91.3%)	114(91.2%)	230(91.3%)
Total	127(100%)	125(100%)	252(100%)

P=0.865, Not Significant, Chi-Square Test

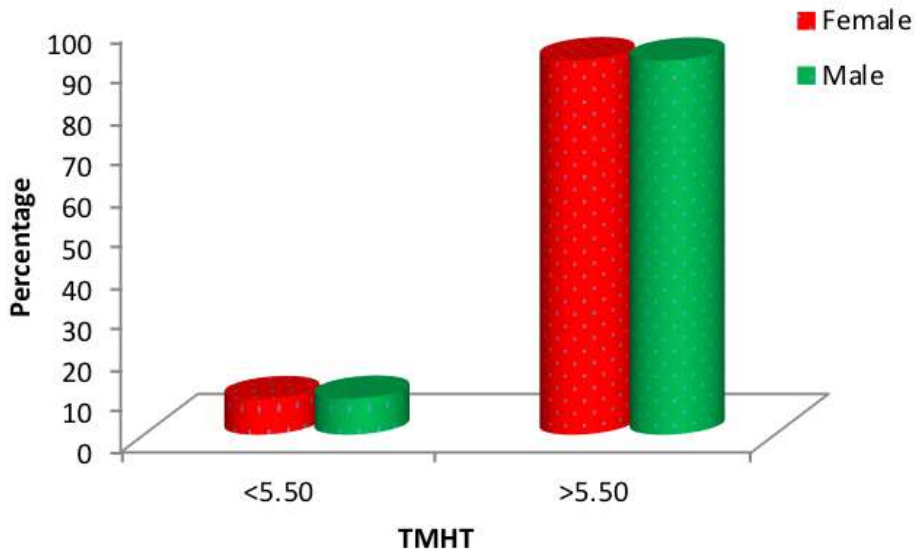

Figure:5

Table 6: USG-VC- frequency distribution of patients studied

USG-VC	Gender		Total
	Female	Male	
≤0.23	112(88.2%)	110(88.0%)	222(88.1%)
>0.23	15(11.8%)	15(12.0%)	30(11.9%)
Total	127(100%)	125(100%)	252(100%)

P=0.963, Not Significant, Chi-Square Test

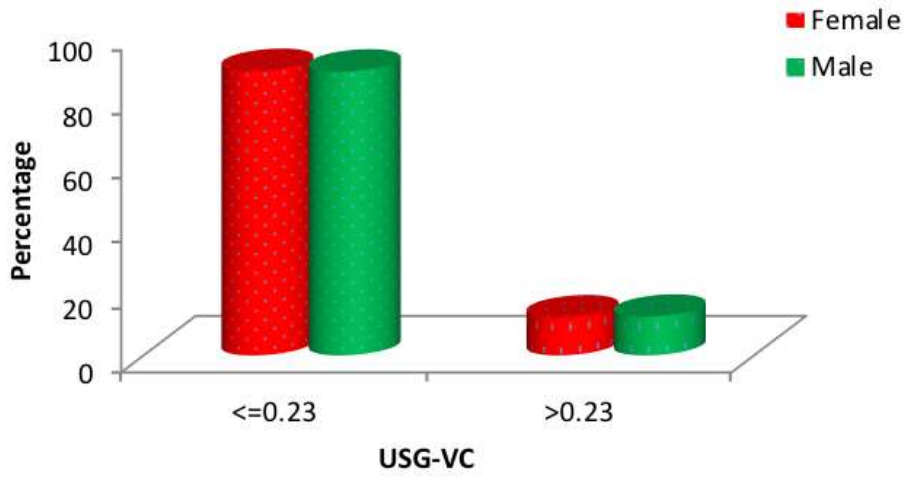

Figure:6

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Table 7: CL GRADE- frequency distribution of patients studied

CL GRADE	Gender		Total
	Female	Male	
1	45(35.4%)	45(36%)	90(35.7%)
2	70(55.1%)	70(56%)	140(55.6%)
3	12(9.4%)	10(8%)	22(8.7%)
Total	127(100%)	125(100%)	252(100%)

P=0.918, Not Significant, Chi-Square Test

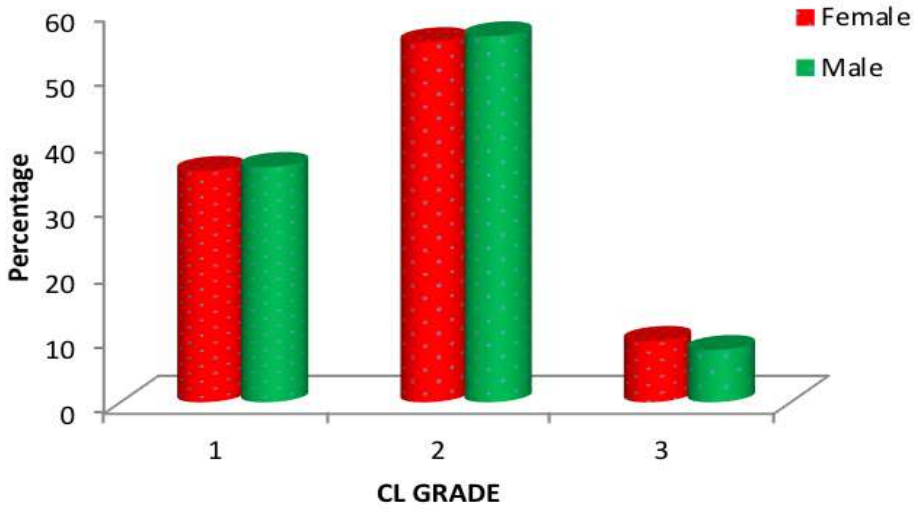

Figure:7

Table 8: AID USED- frequency distribution of patients studied

AID USED	Gender		Total
	Female	Male	
NIL	115(90.6%)	115(92%)	230(91.3%)
YES	12(9.4%)	10(8%)	22(8.7%)
• BOUGIE	12(9.4%)	7(5.6%)	19(7.5%)
• VIDEOLARYNGOSCOPE	0(0%)	3(2.4%)	3(1.2%)
Total	127(100%)	125(100%)	252(100%)

P=0.862, Not Significant, Chi-Square Test

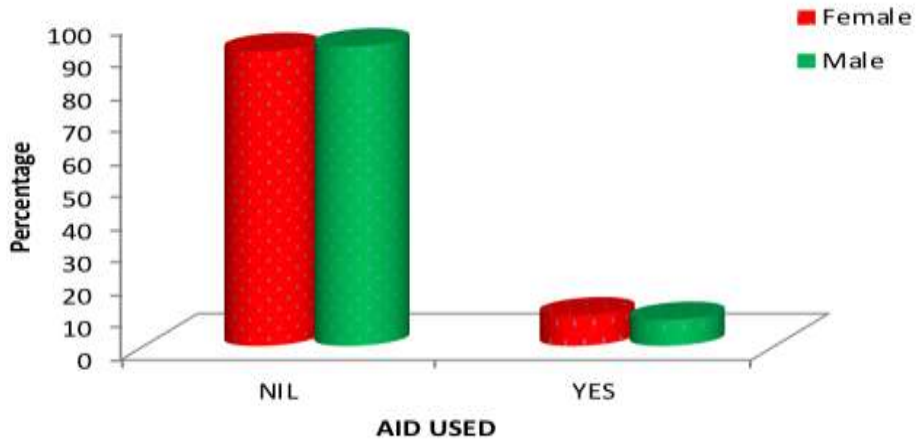

Figure:8

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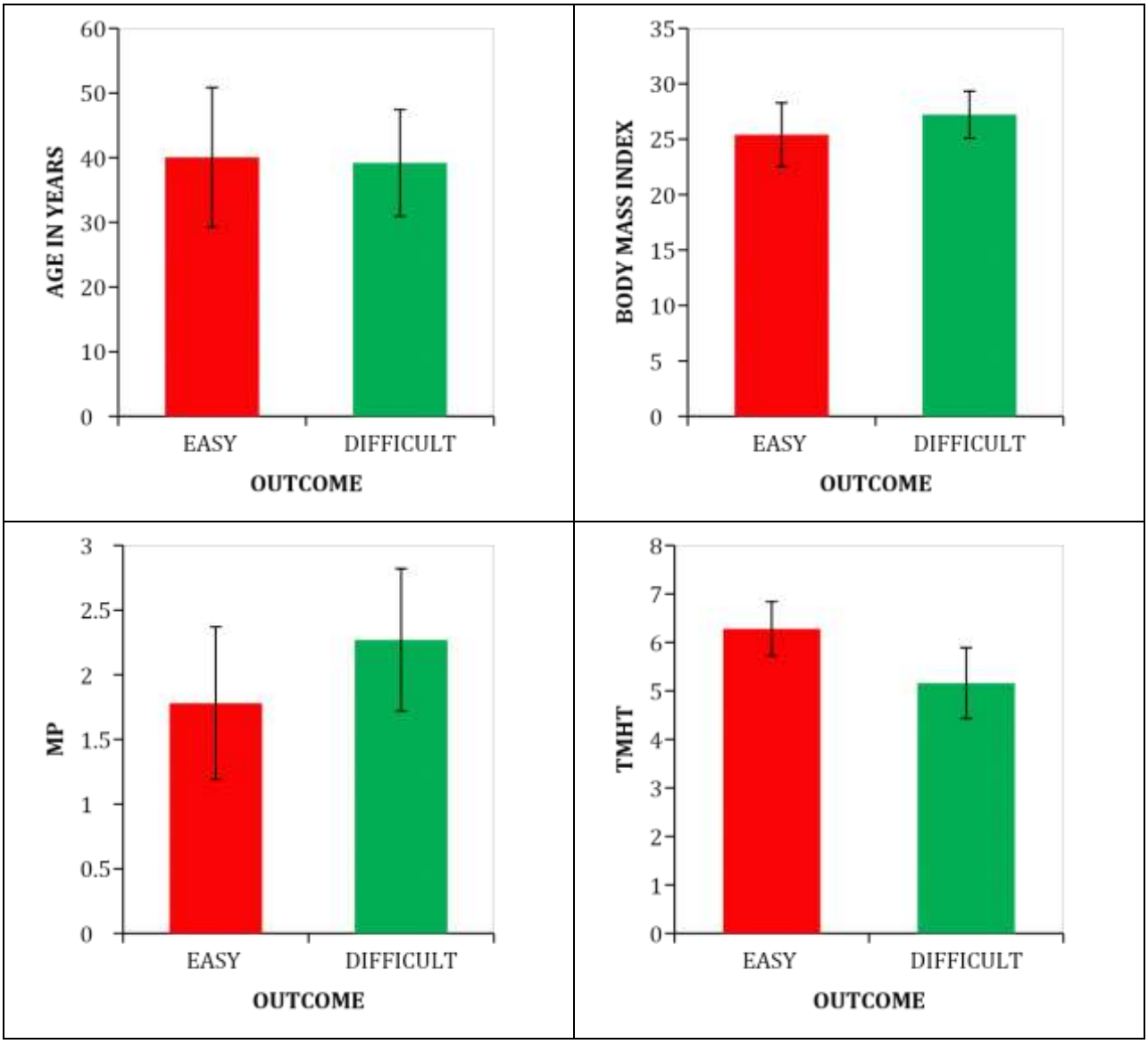
Table 9:comparison of clinical and outcome variables according to gender of patients studied

Variables	OUTCOME		Total	P Value
	EASY	DIFFICULT		
AGE IN YEARS	40.05±10.79	39.18±8.24	39.98±10.58	0.713
BODY MASS INDEX	25.4±2.88	27.21±2.13	25.56±2.87	0.004**
MP	1.78±0.59	2.27±0.55	1.83±0.6	<0.001**
TMHT<5.5cm	6.28±0.56	5.16±0.73	6.18±0.66	<0.001**
USG-VC>0.23cm	0.22±0.01	0.28±0.02	0.23±0.02	<0.001**



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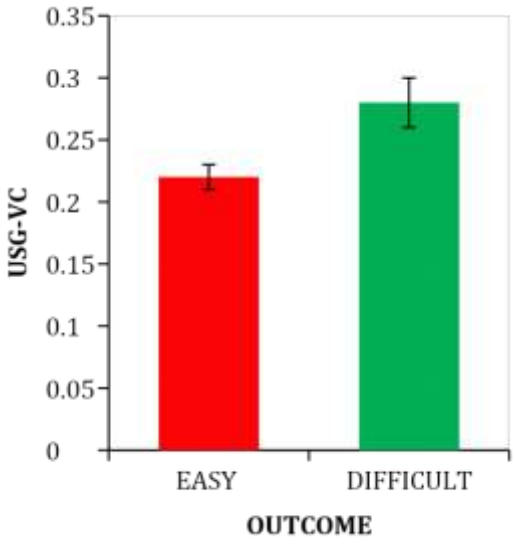

Figure:9

Table 10:CORRELATION OF STUDY VARIABLES ACCORDING TO OUTCOME OF PATIENTS STUDIED

Variables	OUTCOME		Total	P Value
	EASY	DIFFICULT		
MP				
● Easy (1,2)	210(91.3%)	15(68.2%)	225(89.3%)	0.002**
● Difficult(3,4)	20(8.7%)	7(31.8%)	27(10.7%)	
TMHT				
● Easy(>5.5cm)	226(98.3%)	4(18.2%)	230(91.3%)	<0.001**
● Difficult(<5.5cm)	4(1.7%)	18(81.8%)	22(8.7%)	
USG				
● Easy (<0.23cm)	152(66.1%)	2(9.1%)	154(61.1%)	<0.001**
● Difficult(>0.23cm)	78(33.9%)	20(90.9%)	98(38.9%)	
CL GRADE				
● Easy (1,2)	230(100%)	0(0%)	230(91.3%)	<0.001**
● Difficult(3,4)	0(0%)	22(100%)	22(8.7%)	
Total	230(100%)	22(100%)	252(100%)	

Chi-Square Test/Fisher Exact Test

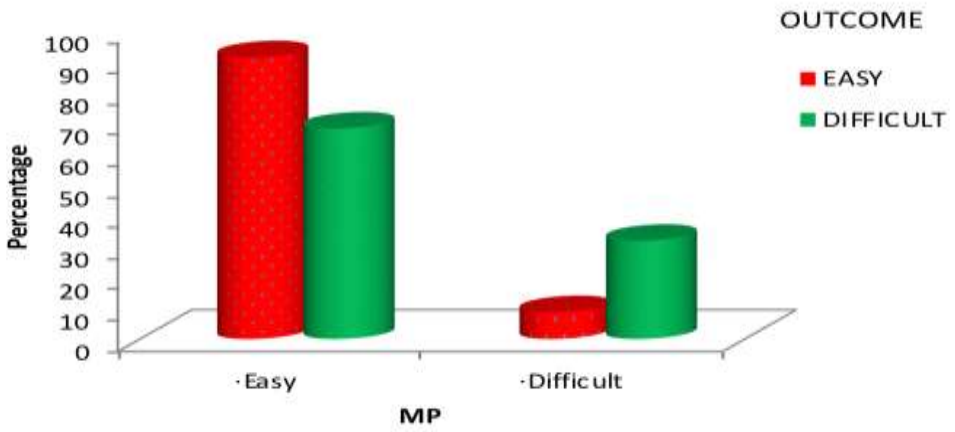

Figure:10a

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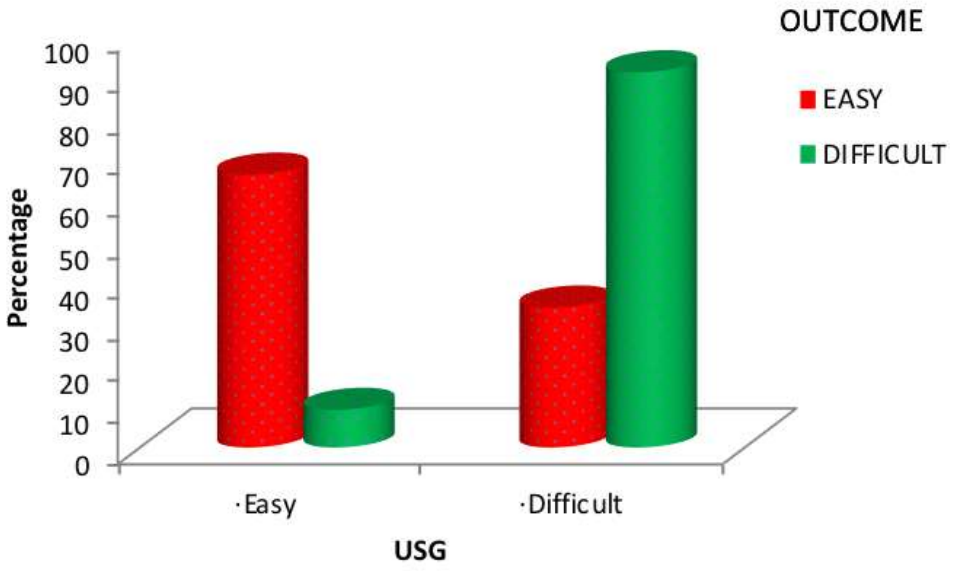

Figure:10b

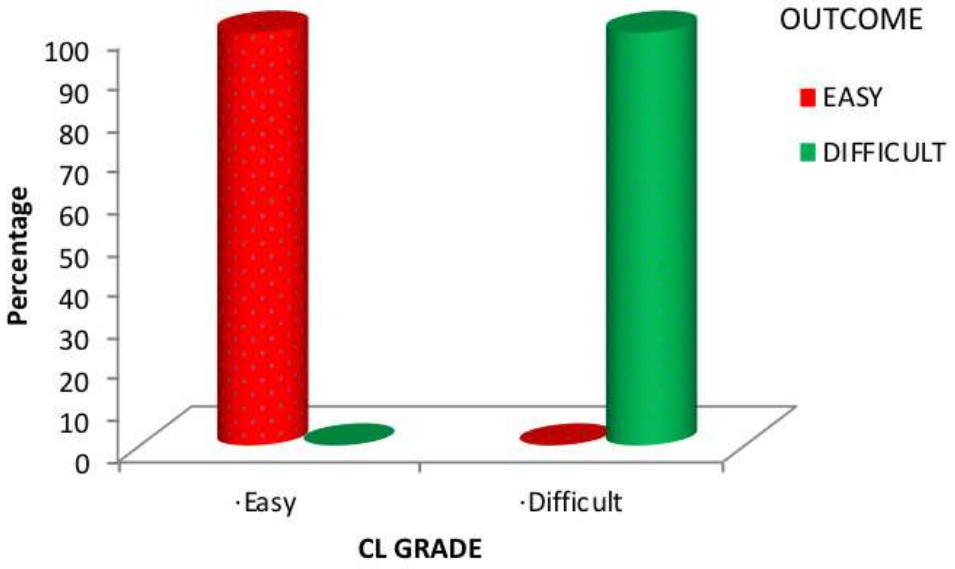

Figure:10c

Table 11: Correlation of findings of study variables l with the findings of outcome of patients studied

Correlation	Observation					Correlation					
	TP	FP	FN	TN	Total	Se	Sp	PPV	NPV	Accuracy	P value
MP	7	20	15	210	252	31.8	91.3	25.9	93.3	86.1	<0.001**
TMHT	18	4	4	226	252	81.8	98.3	81.8	98.3	96.8	<0.001**
USG	20	78	2	152	252	90.9	66.1	20.4	98.7	68.2	<0.001**
CL GRADE	22	0	0	230	252	100.0	100.0	100.0	100.0	100.0	<0.001**

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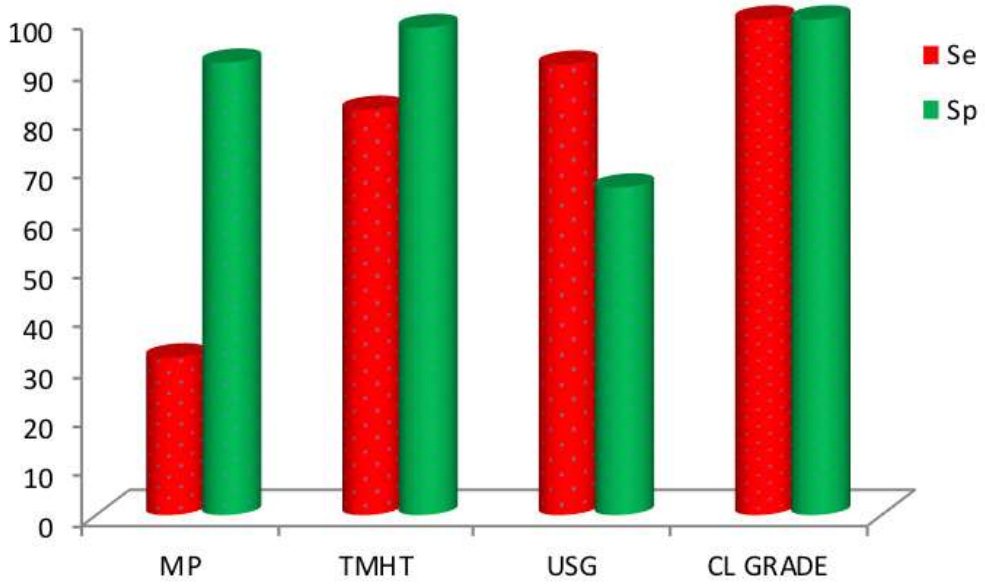

Figure:11

DISCUSSION

The field of anaesthesia has advanced through leaps and bounds but still unforeseen difficult airway still remains a feared scenario for any anaesthesiologist. We do have a battery of easily performable bedside tests for preoperative airway evaluation but unfortunately not even one can authenticate difficult airway categorically in every scenario. The frequency of false positives is very high in the routine test like Modified Mallampatti grading(19), Thyromental distance (Patil's test) (11), Wilson scoring(18). Hence the functionality is questionable(20).

Etezadi *et al* have found a novel airway parameter TMHT which is more sensitive and specific over MMT, SMD, TMD and HMD in foretelling a difficult airway(10) .

Recently Ultrasound has been added to preoperative airway parameter assessments in predicting difficult airway(21). Hence the penumbra overlies in pointing out which is the most prognostic airway parameter sonographically due to lack of studies.

In our study 252 patients(125 males, 127 females) were enrolled out of which 22 patients had Cormack Lehane grade 3 at intubation. Hence the incidence of difficult intubation is 8.7% in our study which is similar and comparable with the previous studies by Smith *et al* (9.7%)(22), Rao *et al* (8.2%) (23).

TMHT was recently proposed as a new difficult airway predictor by Etezadi *et al* (10).
The cut-off for TMHT in the above study was 5cm; which is similar to our study and shows that TMHT< 5.5cm, is a predictor for difficult intubation. The sensitivity , specificity,positive predictive value, negative predictive value and accuracy are 81.82, 98.26, 81.8 , 98.6 and 96.8 respectively.

These data are similar and comparable to the data from Indian population (345 patients) and Iranian patients (314 patients) with 5cm as cut off.(4,5)
Validity indices of TMHT are similar to the studies done by Rao *et al*(23), Jain *et al* (16)

Ultrasonography has emerged as a difficult airway predictor tool especially in scenarios where the patient is unconscious, having difficulty in palpating anatomic landmarks and emergent conditions.
Recent studies by Yadav *et al* (24) have studied ultrasound airway parameters and observed a strong relation between anterior neck soft tissue thickness at the level of vocal cords (ANS-VC) and difficult airway.
Many researchers have studied the anterior neck soft tissue thickness at hyoid bone, thyroid isthmus, thyrohyoid membrane, vocal cords and suprasternal notch. But majority of studies (25,26,27,28) showed ANS-VC to be a better predictor of difficult airway. Hence we also opted to study ANS_VC.

ANS-VC >0.23cm was associated with difficult intubation.. similar results were found by Reddy *et al* (25) and Yadav *et al* (24).

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Sensitivity of ANS – VC was 90.91% in this study which was similar to others.

Modified Mallampatti Test is the most popular clinical tool used to predict difficult airway , but there are many variations due to the compliance of patient, interobserver variability and this can significantly deter the prediction of difficult airway. Hence Modified Mallampatti test is not accurate in predicting difficult airway. The sensitivity and specificity of Modified Mallampatti test (31.8 & 91.3) in our study is comparable to earlier study of Shiga *et al* (29).

Recent data shows Modified Mallampatti Test is not an accurate predictor of difficult airway (29,30,31)
In our study we found TMHT<5.5cm and ANS-VC>0.23cm to be equally good predictor of difficult airway but Modified Mallampatti test had a poor predictability. Amongst all the three parameters studied ANS-VC>0.23cm had the highest sensitivity, specificity , PPV, NPV and Accuracy. TMHT<5.5cm had similar results . So we would like to suggest that ANS-VC had a slightly better edge than TMHT in predicting difficult airway but both are promising parameters which need to be incorporated in our routine preanesthetic checkup for airway.

Limitations of the study
We had a small sample size and we evaluated only one race of people so the results need to be validated on other races as well. Cormack lehane grading can have interindividual variability inspite of the anaesthetist with more than five years experience.

More studies need to be done with ultrasound parameters and correlating with the clinical variables .
Learning curve of the sonoanatomy of airway can have some operator variability.

CONCLUSION
Identifying patients with difficult intubation preoperatively saves the patient and anaesthesiologist in a spectrum of ways. Sonographic parameter ANS-VC >0.23cm is promising in predicting difficult airway. Alongwith this parameter the clinical parameter TMHT <5.5 cm is equally good in predicting difficult airway than Modified Mallampatti test.
Hence we need to develop combined tests of Ultrasound and clinical parameters to improve the predictability of difficult airway.

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