RESEARCH ARTICLE

PREDICTION OF DIFFICULT LARYNGOSCOPY BY ULTRASOUND GUIDED VALUATION OF ANTERIOR NECK SOFT TISSUE THICKNESS.

Joti Kanoujiya[1], Abhay Sancheti[2] and S. Swami[3].

1.   Resident, Department Of Anaesthesiology, Bharati Vidyapeeth University of Medical Science, Pune, India.
2.   Assistant Professor, Department of Anaesthesiology, Bharati Vidyapeeth University of Medical Science, Pune, India.
3.   Professor and HOD, Department of Anaesthesiology, Bharati Vidyapeeth University of Medical Science, Pune, India.

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Abstract

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Background : The major responsibility of the anaesthesiologist is to provide adequate ventilation to the patient. Most vital element for this is the airway. Difficulties in optimal airway management can lead to serious adverse effects and failure can even lead to mortality. We have evaluated the feasibility of sonography as an imaging tool in identifying important airway anatomical structures on the anterior aspect of the neck and correlated the ultrasound-guided measurements of the airway parameters with the Cormack Lehane classification of the direct laryngoscopy for prediction of the difficult airway.

Aim : To predict Difficult Laryngoscopy by Ultrasound guided valuation Of Anterior Neck Soft Tissue Thickness.

Method : The study was a prospective observational study. For this study, n (no of cases) =100 considering power of 95% from the previous study; including patients between the age group of 18 to 65 years, ASA I to III grades, scheduled for elective surgery and requiring general anaesthesia with directlaryngoscopy and endotracheal intubation. Patient with anticipated difficult airway were excluded. Modified Mallampati score, Neck circumference at the level of the thyroid cartilage, Thyromental distance, BMI, distance from skin to hyoid bone and distance from skin to the anterior commissure of vocal cords using the USG machine followed by MCLS grade on laryngoscopy were noted.

Result : With reference to ROC analysis, the optimal cut-offs of DSHB, DSAC, neck circumference and BMI measurements for the prediction of difficult Laryngoscopy is 0.81 cm, 0.92 cm, 35.75cm and 24.8 kg/m^2 respectively with the area under the curves being 0.944, 0.970, 0.801 and 0.745 respectively. Similarly, the optimal cut-off value for modifiedMallampati grades for the prediction of difficult Laryngoscopy is Grade II and above with area under the curves being 0.718. We also found that with experience the required time to measure the distances using USG was reduced with experience.

Conclusion : We conclude from our study that the BMI, modified Mallampati grade and neck circumference are good predictors of

Corresponding Author:-Joti Kanoujiya.
Address:- Resident, Department Of Anaesthesiology, Bharati Vidyapeeth University of Medical Science, Pune, India.

difficult laryngoscopy. However, USG guided measurements at the level of hyoid bone and anterior commissure of vocal cords showed a higher specificity and sensitivity for the prediction of difficult laryngoscopy.

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Introduction:-

The major responsibility of the anaesthesiologist is to provide adequate ventilation to the patient. Most vital element for this is the airway. Airway management is the basic skill acquired and mastered by the anaesthesiologist. Difficulties in optimal airway management can lead to serious adverse effects and failure can even lead to mortality.[1]

Difficult tracheal intubation accounts for 17% of the respiratory-related injuries and results in significant morbidity and mortality. In fact up to 28% of all anaesthesia related deaths are secondary to the inability to mask ventilate or intubate.[2] Recognizing before anaesthesia, the potential for a difficult airway (DA) allows time for optimal preparation, proper selection of equipment and technique and participation of personnel experienced in difficult airway management.

Over the decades, multiple tests and techniques like modified Mallampati classification, thyromental distance, neck circumference and neck movement have been practiced. Earlier the assessment was done by any of these single variants. Later, it was found that multivariate factors for airway assessment like Wilson score, LEMON score were more reliable than the single variates. Modified Cormack Lehane grading is the method used to classify the view obtained during direct laryngoscopy, but being an invasive procedure it cannot be used in pre- anaesthesia check up as a tool for airway assessment.[2]

Even with an exhaustive list of various tests and scoring systems to assess the difficult airway their predictive value for difficult intubation has proven to be inadequate. The specificity of these tests vary vastly, but none of them provide 100% accuracy to alleviate the element of surprise of inability to secure the airway in the operation theater post induction.

The ultrasound (USG) has been in clinical use by anaesthesiologists since 1984 and its use in airway management has been published since then .[3] Ultrasonography (USG) of the upper airway is capable of providing detailed anatomic information and has numerous potential clinical applications. It can be used to identify airway pathology and may assist other methods in prediction of difficulty with airway management.

We have evaluated the feasibility of sonography as an imaging tool in identifying important airway anatomic structures on the anterior aspect of the neck and correlated the ultrasound-guided measurements of the airway parameters with the Cormack Lehane classification of the direct laryngoscopy for prediction of the difficult airway.

Materials:-
1. Ultrasound machine – Sonosite Edge II Wipro GE Logic 400 MR 3
2. Linear frequency – USG probe
3. Measuring tape
4. Laryngoscope

Methodology:-
1. In the preoperative room, the following parameters were observed and noted
2. Modified Mallampati score[4]
3. Class I:Full visibility of tonsils, uvula and soft palate
4. Class II:Visibility of hard and soft palate, the upper portion of
5. tonsil and base of uvula
6. Class III: Soft and hard palate, the base of the tongue arevisible
7. Class IV:Only hard palate visible.

1. Neck circumference at the level of the thyroid cartilage.
2. Thyromental distance with patients neck fully extended.
3. The patient was asked to lie down supine with active maximal head tilt-chin lift. The ultrasound transducer was oriented transversely across the anterior surface of the neck (transverse view).
4. Subsequently, the following structures were assessed and measured using a high-frequency linear probe of the sonosite ultrasound machine.
5. Distance from skin to hyoid bone (in cm)
6. Distance from skin to the anterior commissure of vocal cords (in cm)
7. The time required to identify and measure these distances were noted (in mins).
8. After following standard general anaesthesia protocol, laryngoscopy under muscle relaxant was done and Modified Cormack Lehane score[5] (MCLS) was noted.
9. The USG measurements were then correlated with Cormack Lehane Grading.

Statistics:-
1. The demographic data were compared with the Chi square test.
2. Other parameters were compared using student t-test.
3. ROC curve analysis was used to obtain cut off values for assessing specificity and sensitivity of the parameters
4. In the entire study, the p-values <0.05 is considered to be statistically significant.

The receiver operating characteristic (ROC) curve, which is defined as a plot of test sensitivity as the y coordinate versus its 1-specificity or false positive rate (FPR) as the x coordinate, is an effective method of evaluating the quality or performance of diagnostic tests against a specific Gold standard. This technique was used to find the best predictor of difficult Laryngoscopy.

Observations And Results:-
The study entitled "Prediction of Difficult Laryngoscopy by Ultrasound guided valuation Of Anterior Neck Soft Tissue Thickness" was conducted in 100 patients of both gender and following observations and results were obtained.
The following parameters were studied:
Modified Mallampati classification (MMC) based on relations of oropharyngeal structures.
1. Thyromental distance
2. Neck circumference
3. USG measurements:
4. Distance from the skin to hyoid bone (DSHB)
5. Distance from the skin to the anterior commissure of vocal cords (DSAC)
6. Modified Cormack Lehane score (MCLS)

Table 1a:- Distribution of cases according to modified Cormack Lehane grades (MCLS).

Grades	Status	No. of cases	% of cases
I	Easy	40	40.0
IIa	Easy	30	30.0
IIb	Easy	14	14.0
IIIa	Difficult	8	8.0
IIIb	Difficult	6	6.0
IV	Difficult	2	2.0
Total	--	100	100.0

Grade I – IIb - easy intubation
Grade IIIa – IV – restricted and difficult intubation[5]
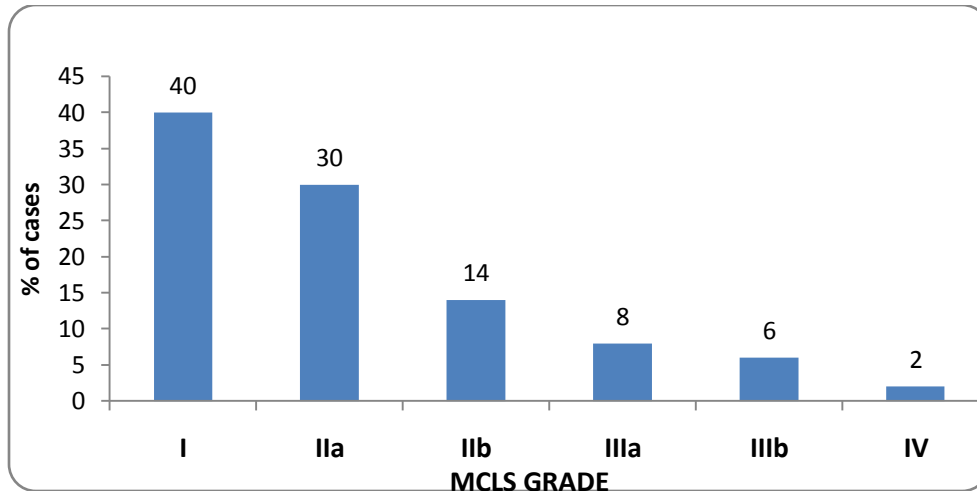
Graph 1:-Distribution of cases according to modified Cormack Lehane grades (MCLS).

Table 1b:-Distribution of cases according to Cormack Lehane score (MCLS).

Grades	Status	No. of cases	% of cases
I to IIb	Easy	84	84.0
IIIa to IV	Difficult	16	16.0
Total	--	100	100.0

Of 100 cases studied, 84 (84.0%) had Easy Laryngoscopy (MCLS Grades I to IIb) and 16 (16.0%) had difficult Laryngoscopy (MCLS Grades IIIa to IV)
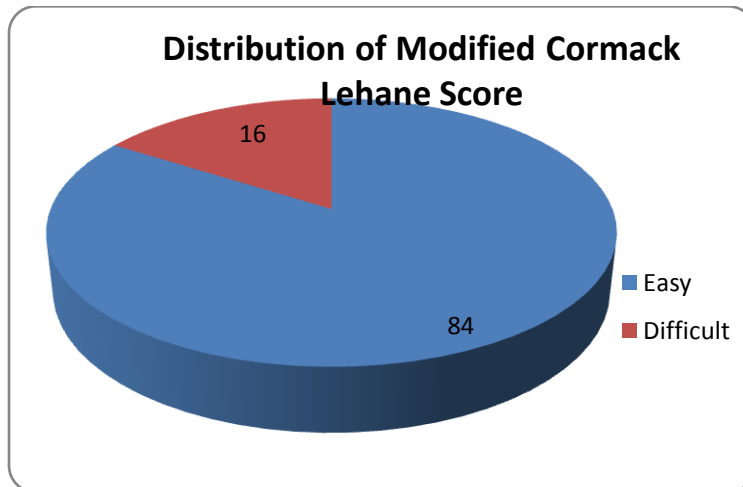

Figure 5:-Distribution of cases according to modified Cormack Lehane score (MCLS).
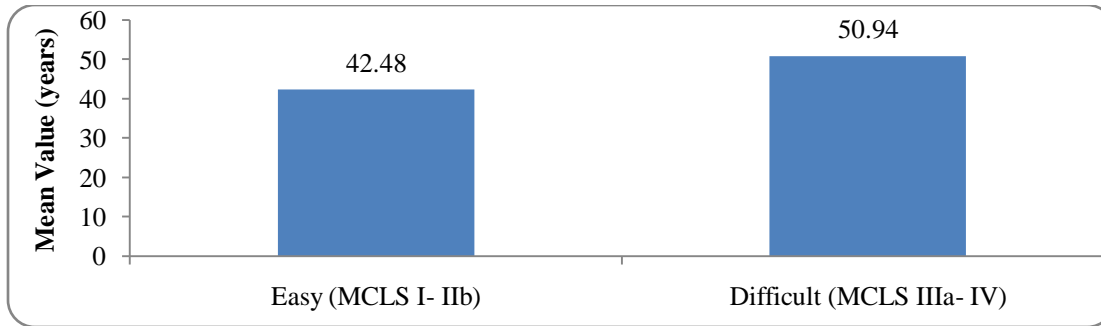
Demographic Data:-
Table 2:-Distribution of mean age in relation with Cormack Lehane grades (MCLS).

Parameter	Cormack Lehane Grades						P-value
	Easy (n=84) {MCLS I- IIb}			Difficult (n=16) {MCLS IIIa-IV}			
	Mean	SD	Min – Max	Mean	SD	Min – Max	
Age (years)	42.48	16.01	18 – 85	50.94	14.48	24 – 70	0.052[NS]
P-value by independent sample t-test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.							

The distribution of mean age did not differ significantly between a group of cases with easy and difficult laryngoscopy (P-value>0.05).
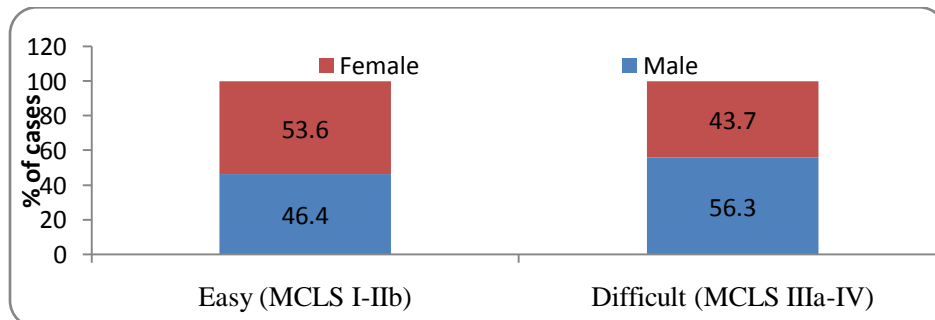
Graph 2:-Distribution of mean age in relation with Cormack Lehane grade (MCLS).

Table 3:-Sex distribution of cases in relation with Cormack Lehane grades (MCLS).

	Cormack Lehane Grades				
	Easy (n=84) MCLS Grade I - IIb		Difficult (n=16) MCLS Grade IIIa - IV		P-value
Sex	n	%	n	%	
Male	39	46.4	9	56.3	0.471[NS]
Female	45	53.6	7	43.7	
Total	84	100.0	16	100.0	
P-value by Chi-Square test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.					

The sex distribution of cases studied did not differ significantly between a group of cases with easy and difficult laryngoscopy (P-value>0.05).
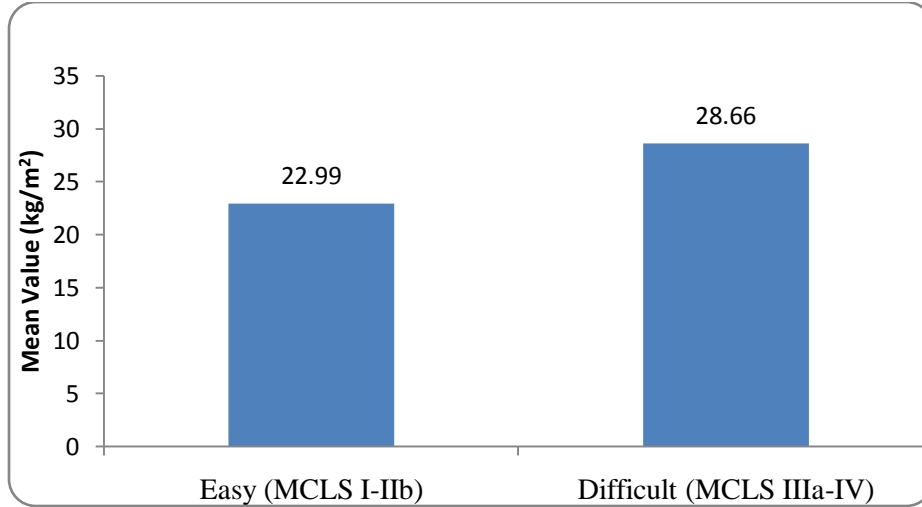

Graph 3:-Sex distribution of cases studied cases in relation t o Cormack Lehane grades (MCLS).

Table 4:-Distribution of mean BMI in relation with Cormack Lehane grades (MCLS)

	Cormack Lehane Grades						
Parameter	Easy (n=84) MCLS Grade I - IIb			Difficult (n=16) MCLS Grade IIIa - IV			P-value
	Mean	SD	Min – Max	Mean	SD	Min – Max	
BMI (kg/m^2)	22.99	4.56	15.00 – 37.90	28.66	7.01	19.00 – 42.00	0.001[***]
P-value by independent sample t-test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001 (Statistically significant).							

The distribution of mean BMI is significantly higher among the group of cases with difficult laryngoscopy compared to the group of cases with easy laryngoscopy (P-value<0.001).
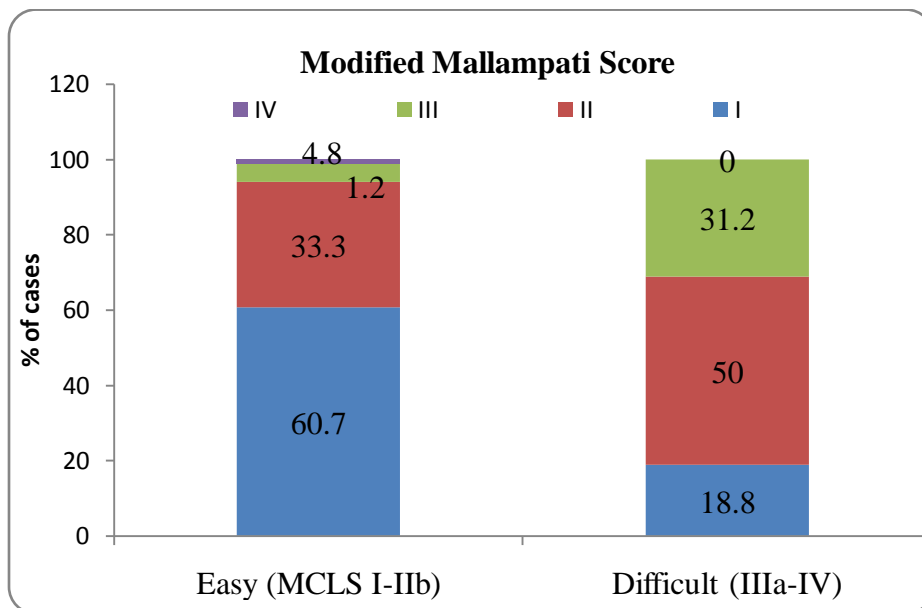
Graph 4:-Distribution of mean BMI in relation with Cormack Lehane grades (MCLS).

Table 5:-Distribution of Mallampati grades in relation with modified Cormack Lehane score (MCLS).

Mallampati Grades	modified Cormack Lehane score				P-value
	Easy (n=84) MCLS Grade I - IIb		Difficult (n=16) MCLS Grade IIIa - IV		
	n	%	n	%	
I	51	60.7	3	18.8	0.001***
II	28	33.3	8	50.0	
III	4	4.8	5	31.2	
IV	1	1.2	0	0.0	
Total	84	100	16	100	
P-value by Chi-Square test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001 (Statistically significant).					

The distribution of Mallampati grades of cases studied differs significantly between a group of cases with easy and difficult laryngoscopy (P-value<0.001).
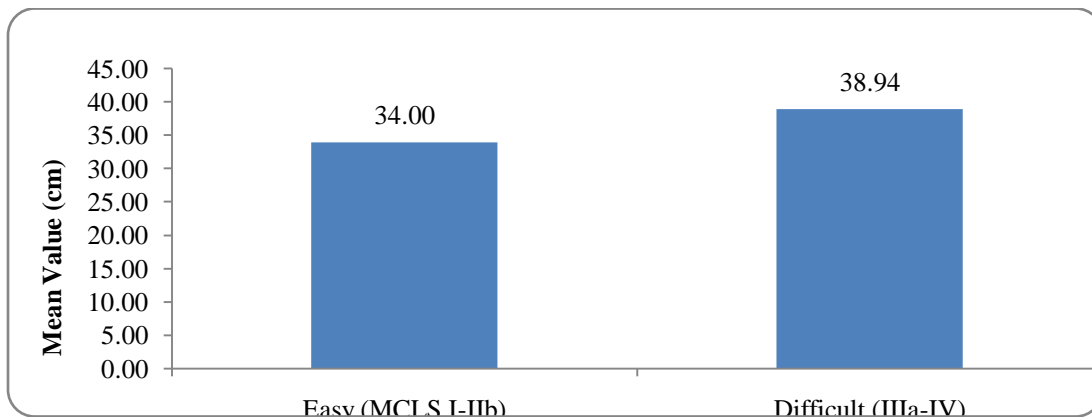

Graph 5:-Distribution of Modified Mallampati grade in relation with modified Cormack Lehane score (MCLS)

Table 6:-Distribution of mean neck circumference with respect to Cormack Lehane grades (MCLS)

Parameter	Cormack Lehane Grades						P-value
	Easy (n=84) {MCLS I -IIa}			Difficult (n=16) {MCLS IIIa-IV}			
	Mean	SD	Min – Max	Mean	SD	Min – Max	
Neck circumference (cm)	34.00	3.95	21.00 – 44.00	38.94	4.48	30.00 – 47.00	0.001***
P-value by independent sample t-test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001.							

The distribution of mean neck circumference is significantly higher among the group of cases with difficult laryngoscopy compared to the group of cases with easy laryngoscopy (P-value<0.001).
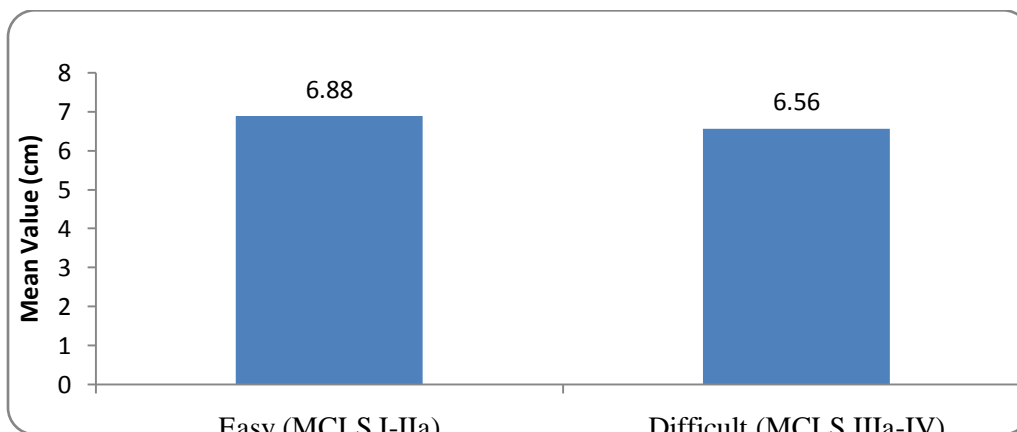

Graph 6:-Distribution of mean neck circumference with respect Cormack Lehane grades (MCLS).

Table 7:-Distribution of mean thyromental distance in relation with Cormack   Lehane grades (MCLS).

Parameter	Cormack Lehane Grades						P-value
	Easy (n=84) {MCLS I -IIa}			Difficult (n=16){MCLS IIIa-IV}			
	Mean	SD	Min – Max	Mean	SD	Min – Max	
Thyromental distance (cm)	6.88	1.37	3.00 – 9.50	6.56	1.64	4.00 – 9.00	0.407NS
P-value by independent sample t-test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.							

The distribution of mean thyromental distance did not differ significantly between a group of cases with easy and difficult laryngoscopy (P-value>0.05).
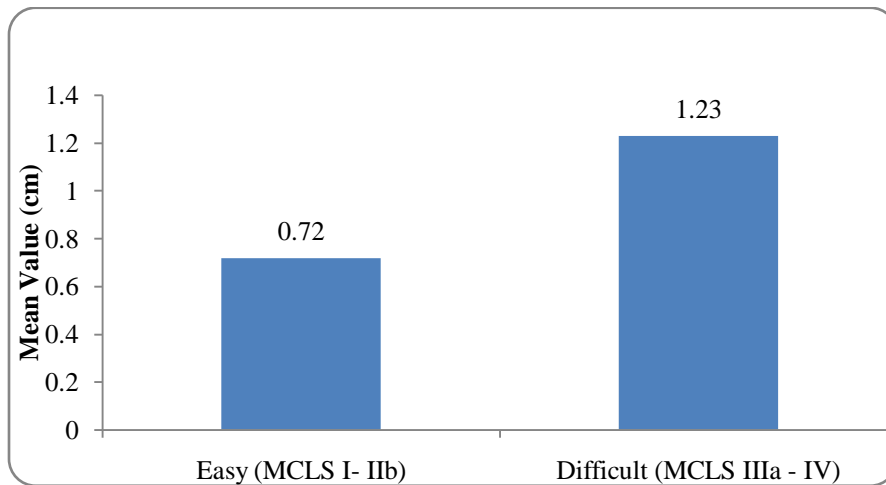

Graph 7:-Distribution of mean thyromental distance in relation with Cormack Lehane grades (MCLS)

Table 8:-Distribution of mean of distance between skin to hyoid bone (DSHB) and the distance between skin to anterior commissure (DSAC) in relation to the modified Cormack Lehane score (MCLS).
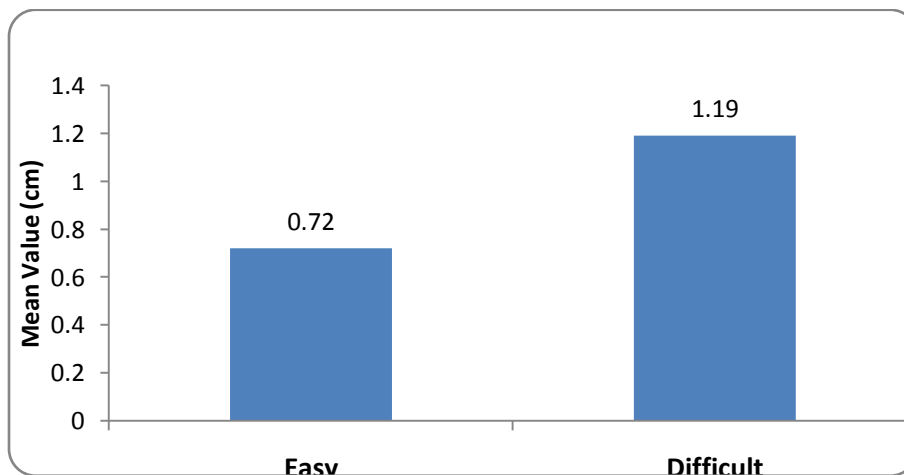
Parameters		Modified Cormack Lehane score		P-value
		Easy (n=84) MCLS Grade I - IIa	Difficult (n=16) MCLS Grade IIIa- IV	
DSHB (cm)	Mean ± SD	0.72 ± 0.15	1.23 ± 0.31	0.001***
	Minimum Maximum	0.45 1.07	0.73 1.78	
DSAC (cm)	Mean ± SD	0.72 ± 0.16	1.19 ± 0.23	0.001***
	Minimum Maximum	0.41 1.10	0.90 1.69	
P-values by independent sample t test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001 (Statistically significant).				

The distribution of mean DSHB is significantly higher in Difficult Laryngoscopy group compared to easy laryngoscopy group (P-value<0.001).

Graph 8:-Distribution of mean of distance between skin to hyoid bone (DSHB) in relation to the modified Cormack Lehane score.

Graph 9:-Distribution of mean of distance between skin to anterior commissure (DSAC) in relation with modified Cormack Lehane score.

Table 10:-Distribution of area under the ROC curves (AUC) forthe distance between skin to hyoid bone (DSHB) and the distance between skin to anterior commissure (DSAC), BMI, Neck circumference, thyromental distance and Mallampati grades for the prediction of difficult Laryngoscopy.

| Parameter	Optimal Cut-Off Based on ROC	AUC ± SE	95% CI of AUC	P-value
DSHB	0.81 cm	0.944 ± 0.028	0.888 – 0.999	0.001[***]
DSAC	0.92 cm	0.970 ± 0.015	0.940 – 0.999	0.001[***]
Modified Mallampati Grades	Grade II	0.718 ± 0.073	0.574 – 0.862	0.006[**]
Thyromental distance	6.25 cm	0.454 ± 0.086	0.285 – 0.622	0.559[NS]
Neck circumference	35.75 cm	0.801 ± 0.064	0.674 – 0.927	0.001[***]
BMI	24.8 kg/m^2	0.745 ± 0.074	0.599 – 0.891	0.002[**]
**P-value<0.01 (Statistically significant), ***P-value<0.001 (Statistically significant), NS-Statistically non-significant. Reference value = 0.500. SE – Standard Error.				
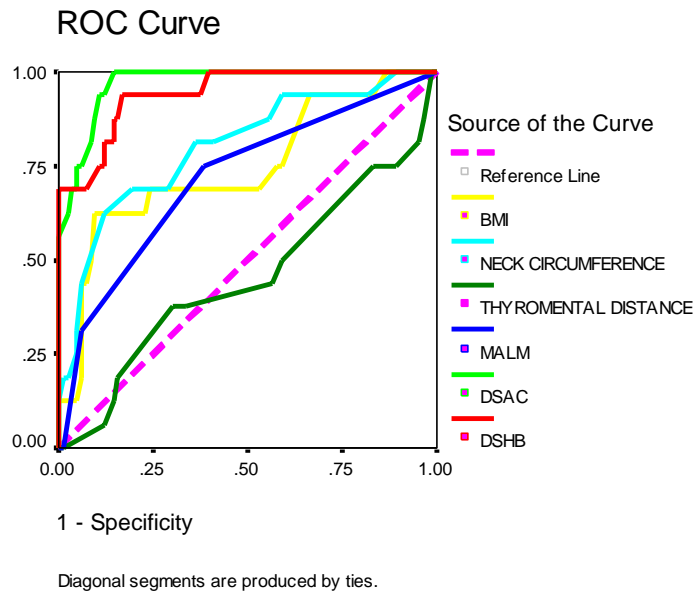
Figure 6:-Receiver operating characteristic (ROC) analyses for DSHB (red line), DSAC (light green line), Modified Mallampati grades (blue line), Thyromental distance (dark green line), neck circumference (light blue line) and BMI (yellow line). Cormack-Lehane grading of glottis exposure over II was considered the threshold of difficult laryngoscopy during the study. Pink dotted line=reference line. DSHB: the minimum distance from skin to hyoid bone; DSAC: the minimum distance from skin to the anterior commissure.

From the ROC curve analysis, it is clear that the distribution of area under the curve (AUC) differs significantly for DSHB, DSAC, Modified Mallampati grades and neck circumference for the prediction of difficult Laryngoscopy from the reference value of 0.500 (P-value<0.01 for all). The distribution of area under the curve (AUC) did not differ significantly for thyromental distance for the prediction of difficult Laryngoscopy from the reference value of 0.500 (P-value>0.05).

With reference to ROC analysis, the optimal cut-offs of DSHB, DSAC, neck circumference and BMI measurements for the prediction of difficult Laryngoscopy is 0.81 cm, 0.92 cm, 35.75cm and 24.8 kg/m2 respectively with the area under the curves being 0.944, 0.970, 0.801 and 0.745 respectively.

With reference to ROC analysis, the optimal cut-off value for modified Mallampati grades for the prediction of difficult Laryngoscopy is Grade II and above with area under the curves being 0.718.

Parameter	Sensitivity	Specificity	PPV	NPV	Accuracy
DSHB	93.7	80.9	48.4	98.5	83
DSAC	93.7	89.2	62.5	98.7	89.9
Modified Mallampati Grades	81.2	60.7	28.3	94.4	64
Thyromental distance	50	40.5	13.8	80.9	42
Neck circumference	81.2	64.3	30.2	94.7	67
BMI	68.7	76.2	35.5	92.7	75

Table 12:-Distribution of mean time required to perform the ultrasound measurements in two Groups.

	Group 1 (n=50) (First 50 Cases)		Group 2 (n=50) (Second 50 Cases)		P-value
	Mean	SD	Mean	SD	
Time Taken (Mins)	1.52	0.54	1.05	0.13	0.001***
P-values by independent sample t-test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001 (Statistically significant).					

The mean $\pm$ SD of time taken to complete the measurement in Group 1 and Group 2 was 1.52 $\pm$ 0.54 mins and 1.05 $\pm$ 0.13 mins respectively. The distribution of the mean time taken to complete the measurements is significantly higher in Group 1 compared to Group 2 (P-value<0.001).
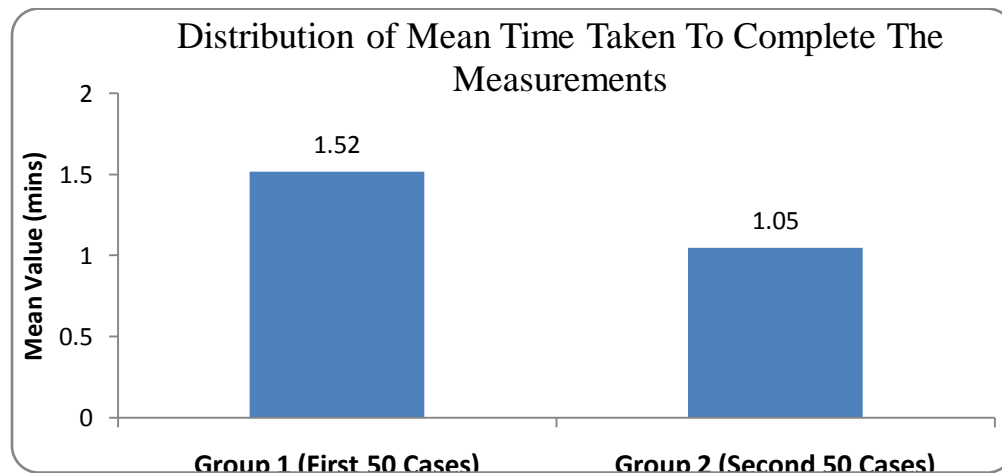
Graph 12:-Distribution of mean time required to perform the ultrasound measurements in two Groups

Discussion:-

The major responsibility of anaesthesiologist is to provide adequate ventilation to the patient. Recognizing before anaesthesia, the potential for a difficult airway (DA) allows time for optimal preparation, proper selection of equipment and technique in difficult airway management. The concept of ruling out difficult airway as a part of pre-anaesthesia checkup was started by Vijayalakshmi Patil.[6]

With latest advancements of ultrasonography, attempts have been made to widen its horizon of utility due to its accuracy along with patient-friendly non-invasive technique. In this study, we aimed to assess and prepare beforehand for unanticipated difficult airway in the operation theater.

Our study was a prospective observational type of study, carried out in attached hospital to assess the efficacy of ultrasonogram as a tool to measure the thickness of anterior neck soft tissue thickness at the level of hyoid bone and anterior commissure of vocal cord and correlate with modified Cormack Lehane score to predict difficult laryngoscopy.

Table 1a/1b, Graph 1:-
Out of 100 patients who participated in this study, there were 84 patients who belonged to easy laryngoscopy group (MCLS grade I to IIb) whereas the rest 16 belonged to laryngoscopy group (MCLS grade IIIa to IV).
The patient's demographic profile was analyzed for any statistical significance.

Table 2/ Graph 2:-
This study included patients falling in the age group of 18 – 65 yrs of age. The larynx starts to develop as early as the third week of gestation and is completely developed by the end of the second trimester. At infancy, the larynx is present at the level of C2-C3vertebra, with the advancement of age the larynx descends down to the adult level which is C3-C6 vertebra. This descends varies in gender. In females, the descend stops at an early age whereas it stops at puberty in the male population. Whereas with age there are changes in the body which make the airway difficult. Therefore, to prevent any differences in airway measurements due to age-related discrepancies we had excluded patients younger than 18 years or older than 65 years. But age did not differ significantly with respect to MCLS in our study.

Table 3/ Graph 3:-
The sex distribution of cases studied did not differ significantly between a group of cases with easy and difficult laryngoscopy (P-value>0.05).

Table 4/Graph 4:-
Voyagis, et al.(1998)[7] and Wu J et al.[8]reported that difficult intubation increases with increasing Body Mass Index (BMI).Hence our results regarding the BMI of the subjects also support their finding, as the distribution of mean BMI in our study is significantly higher among the group of cases with difficult laryngoscopy compared to the group of cases with easy laryngoscopy (P-value<0.001) evident from table 4 and graph 4.

Table 5/ Graph 5:-
Ezri, et al.[9], suggested in their study that Mallampati score poorly predicted difficult laryngoscopy.Wu J, et al.[8]**,** they found the Modified Mallampati score to have a significant p-value <0.0001 with a sensitivity of 50% and specificity of 82.3% concluding that modified Mallampati score was a good parameter in favor to assess difficult laryngoscopy but can be used as a part of multifactorial model for the prediction of difficult tracheal intubation.

Reddy, et al.[10], also found in their study that modified Mallampati score (≥ 3) is one of the good predictors of difficult intubation with a sensitivity of 71.4 %, specificity of 83.7%

Whereas our study concludes with the distribution of Mallampati grades of cases studied differs significantly between a group of cases with easy and difficult laryngoscopy (P-value<0.001); with a sensitivity of 81.2% and specificity 60.7%; but it's accuracy was merely 64%. This shows that the predictability of difficult laryngoscopy with the modified Mallampati score is not a dependable variable.

Table 6/ Graph 6:-
Out of the demographic data, we had also evaluated neck circumference within the study group which lead us to a significant statistical difference with p<0.001 (neck circumference >36.75cm in difficult laryngoscopy). Therefore results from our study correlates with the work done by **Brodsky, et al.[11]**who stated that neck circumference is a valuable predictor of difficult laryngoscopy in obese patients.

Table 7/ Graph 7:-
Ezri et al.[9] , Wu et al.[8] and Reddy et al.[10]all showed a similar opinion regarding TMD in their study, stating that TMD is not a reliable screening test for predicting difficult laryngoscopy. Results from our study with regards to TMD favor their opinion as a poor predictor for difficult laryngoscopy (evident from Table7 and Graph 7).
The measurements taken down with the help of USG were used to identify and label the patient as the difficult airway.

Table 8/ Graph 8:-
Ezri, et al. in 2003.[9] in their study arrived with the result that patients with a larger distance between skin and hyoid bone (>2.8cm) had difficult laryngoscopy; which was comparable to results from our study. In our study, anterior neck soft tissue thickness at the level of hyoid bone >0.81cm were good predictors of difficult laryngoscopy

In 2011, SrikarAdhikari, et al.[12] demonstrated in their study that the sonographic measurement of the anterior neck soft tissue thickness at the level of hyoid bone >1.69cm (95 %, CI = 1.19 to 2.19) could be used to distinguish difficult laryngoscopy; this result could be related to our result in which it was evident that distance from skin to hyoid bone of more than 0.81cm was the cut off value to label the patient with difficult laryngoscopy.

Mirulnalini, et al. in 2015[13], conducted a similar study, in which they found the distance between skin to hyoid bone to be statistically highly significant, with cut off value of 0.78 cm which is close to our result of statistical significance and cut off value of 0.81cm for prediction of difficult laryngoscopy. In contrast to their sensitivity of 63.6%, this parameter had the sensitivity of 93.7%.

Table 8/ Graph 9:-
Reddy, et al.(2016)[10] came up with the result that anterior neck soft tissue thickness at the level of vocal cords of > 0.23cm had a sensitivity of 85.7% in predicting a Cormack Lehane Grade III or IV, which was higher than that of modified Mallampati Grade of 3 or 4 denoting difficult laryngoscopy. Whereas in our study anterior neck soft tissue thickness at the level of vocal cords more than 0.92cm was exclusive for difficult laryngoscopy with the sensitivity of around 97%, comparatively higher than modified mallampati scoring. Though our measurements were greater than the study done by Reddy, et al. our study's inference matched with their conclusion.

Results of a study conducted by Wu J, et al. in 2014[8], which showed that the optimal cut off values for modified mallampati score, distance from skin to hyoid bone and anterior commissure to predict difficult laryngoscopy were over MMC grade 2, 1.28 cm and 1.1 cm respectively which were comparable to our results; in which the cut off values for modified mallampati score (more than 2), hyoid bone depth (>0.81cm), and anterior commissure dept (0.92cm) were individually associated with difficult laryngoscopy (summarized in table10).

To summarize the results from our study; out of the 16 patients with difficult laryngoscopy, 11 patients were of grade I and II. This means that modified mallampati grading could not predict difficult laryngoscopy in these 11 patients which shows its lower predictability value than the USG measurements. Graph 5 and Table 5 depicts the above-mentioned inference.

Patients with the neck circumference greater than 35.75cm had a significant predictive value for difficult laryngoscopy as depicted in graph 3. Whereas thyromental distance had no significance when correlated with MCLS, hence it cannot be considered as a sole reliable predictor.

On correlating USG measurements of DSHB and DSAC with MCLS grade, it was found that anterior neck soft tissue thickness at the level of the hyoid bone of range 0.73 cm to 1.78 cm was able to predict difficult laryngoscopy in 93.7% of patients with MCLS corresponding to difficult laryngoscopy. Similarly, DSAC of range 0.90 to 1.62cm could predict difficult airway in 93.7% of patients.

ROC curve analyses was done for all the clinical parameters considered for prediction along with the USG measurements and area under the curve were identified to obtain the cut off values. The accuracy of the test depends on how well the test separates the groups being tested. Accuracy is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of 0.5 represents a worthless test. A rough guide for classifying the accuracy of a diagnostic test is the traditional academic point system:
1.   0.90 - 1 = excellent

2.   0.80 - 0.90 = good
3.   0.70 - 0.80 = fair
4.   0.60 - 0.70 = poor
5.   0.50 - 0.60 = fail

Table 10 / Table 11:-
ROC curve analysis of the thickness of anterior neck soft tissues at the hyoid bone level:-
Cut off value is 0.81 cms. Area under the curve is 0.94, which means that accuracy of the test is "excellent"
Sensitivity was 93.7% sensitive. Specificity 80.9% was specific.

ROC curve analysis of the thickness of anterior neck soft tissues at the anterior commissure level (DSAC):-
Cut off level is 0.92cms.Area under the curve is 0.97 which means the accuracy of the test is "excellent".Sensitivity
was 93.7% sensitive.Specificity was 80.9% specific.

ROC curve analysis for modified mallampati grading (MMC):-
Cut off level is MP grade II Area under the curve is 0.718 which means the accuracy of the test is "fair".Sensitivity
was 81.2% sensitiveSpecificity was 60.7% specific

ROC Curve analysis for thyromental distance:-
Cut off level is 6.25cms.Area under the curve is 0.45 which means the accuracy of the test is "fail".

ROC Curve analysis for neck circumference:-
Cut off level is 35.75cms.Area under the curve is 0.80 which means the accuracy of the test is "fair".Sensitivity was
81.2% sensitive.Specificity was 64.3% specific.

ROC curve analysis of BMI:-
The cutoff point is 24.8 kg/m^2.Area under the curve is 0.745, which means that accuracy of the test is "fair"
Sensitivity was 68 .7% sensitive.Specificity 76.2% was specific.

So based on outcome analysis it was found that ultrasonogram can be used as a safe, less time consuming and
potential tool in predicting difficult intubation preoperatively by measuring the thickness of anterior neck soft
tissues. The increased thickness of the soft tissues was associated with increased difficulty in intubation.

Also based on ROC analysis, it was evident that USG measurements at the level of anterior commissure (with range
0.73cm to 1.78cm) are more accurate, more sensitive and more specific in detecting the occurrence of the difficult
intubation followed by measurement at the level of hyoid bone (with range 0.90cm – 1.69cm), neck circumference
(>35.75CM) and modified mallampati grade (>GRADE 2).

Table 12/ Graph 12
Secondarily, we had statistically analyzed the time required to assess and measure the airway structures using USG.
We found that with experience the required time to measure the distances using USG was reduced. Hence based on
statistics we can conclude that Ultrasonogram can be used as an independent tool for assessing airway, which will be
helpful in cases of emergency intubations without consuming much of the precious time.

Summary:-
We have conducted a prospective observational study to predict difficult laryngoscopy by Ultrasound guided
measurement of Anterior Neck Soft Tissue Thickness preoperatively and correlation of these measurements with
Cormack- Lehane in 100 patients planned for elective surgery under general anaesthesia requiring intubation.

Our study included demographic details like age and sex, which were comparable. The comparison of BMI with
MCLS grading was statistically significant with a higher BMI corresponding with a higher MCLS grade.The
modified Mallampati Grade of 2 or more correlated with difficult laryngoscopy in our study. Also, our study showed
that the neck circumference of more than 35.75cm indicated difficult intubation. However, the thyromental distance
was not statistically significant when compared with MCLS.

Whenthese patients were evaluated using USG, the distance from skin to hyoid bone and skin to the anterior commissure of vocal cords were statistically significant when compared with MCLS. We also found that with experience the required time to measure the distances using USG was reduced.

Conclusion:-

We conclude from our study that the BMI, modified Mallampati grade and neck circumference are good predictors of difficult laryngoscopy. However, USG guided measurements at the level of hyoid bone and anterior commissure of vocal cords showed a higher specificity and sensitivity for the prediction of difficult laryngoscopy.

Thus, with advancements in hospital economy and easy availability of portable Ultrasound machines; we as anaesthesiologists can use USG as a clinical tool for assessing airway in order to rule out difficult airway and prepare the anaesthesia workstation for the benefit of the patient. Hence avoid the chaotic scenario of cannot ventilate and cannot intubate.

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