ORIGINAL RESEARCH PAPER

Anaesthesiology

"A PROSPECTIVE OBSERVATIONAL STUDY TO DETERMINE THE USEFULLNESS OF ULTRASOUND GUIDED AIRWAY ASSESSMENT PREOPERATIVELY IN PREDICTING DIFFICULT AIRWAY"

KEY WORDS:

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ABSTRACT

Aim: The primary aim of this study was to assess the usefulness of ultra sonogram as a preoperative assessment tool in identifying difficult airway.

Methodology: 141 patients who were to undergo elective surgery under general anesthesia and required endotracheal intubation were included in the study. Preoperatively ultrasound guided airway assessment was done to measure the thickness of soft tissues in the anterior neck at three levels namely (a) Hyoid bone, (b) Thyrohyoid membrane and (c) Suprasternal notch. The patient's demographic details like age, sex, BMI were also recorded. On the day of surgery, the attending anesthesiologist provided anesthesia to the patient according to standard protocol. Direct laryngoscopy was done and the Cormack-Lehane grading of larynx was recorded.

Results: The statistic analysis tools that were used in this study for comparison between demographic variables, ultrasound measurements and Cormack-Lehane classification was independent t test and Chi square test. There was no statistical significance between the demographic variables like age, sex and BMI of the patients. The ultrasound measurements made at the three levels (a) Hyoid bone, (b) Thyrohyoid membrane and (c) Suprasternal notch showed that increase in anterior neck soft tissue thickness correlates with the increasing difficulty of intubation. On Receiver Operating Characteristic curve (ROC) curve analysis, among the three levels, the measurement made at thyrohyoid membrane level (skin to epiglottis thickness) was found to be highly sensitive (88.9%) and specific (88.6%). A cutoff point of 2.08cms was found to delineate easy and difficult airway.

Conclusion: Based on this study we concluded that ultrasound can be used as a reliable tool to identify difficult airway by measuring the thickness of soft tissues in the anterior part of neck. We found that there is significant correlation between the thickness of soft tissue at the thyrohyoid membrane level and difficulty in intubation.

INTRODUCTION:

The fundamental responsibility of an anesthesiologist is to maintain adequate oxygenation during surgical procedure. Failure to maintain a proper airway for more than few minutes results in brain damage or death. In 1990 closed claims analysis showed that 85% of respiratory event related closed malpractice claims involved a brain damaged or dead patient[1]. In any patient the greater the difficulty in maintaining the airway patency greater the risk of brain damage or death.

The ASA Task force[2] defined "difficult mask ventilation" as occurring when :

1)It is not possible for an unassisted anesthesiologist to maintain the SPO2> 90% using 100% oxygen and positive pressure mask ventilation in a patient whose SPO2 was > 90% before anesthetic intervention; and/or

2) It is not possible for the unassisted anesthesiologist to prevent or reverse signs of inadequate ventilation during positive pressure mask ventilation.

And "difficult endotrachael intubation" as occurring when proper insertion of the tracheal tube with conventional laryngoscopy requires more than three attempts or more than 10 minutes[2].

Identification of difficult airway before manipulation is the Holy Grail of clinical management. Selection of airway devices and techniques all pivot on airway evaluation. A few risk factors for difficult mask ventilation include massive jaw, edentulous patients, obesity, h/o obstructive sleep apnea, burns, inadequate mouth opening etc. But many of the abnormalities cannot be diagnosed by classic airway examination techniques .

The usual scores used for airway evaluation are Mallampati or Samsoom classification[3,4], where oropharynx is divided into four grades on the basis of structures visualised after opening the mouth . Higher the Mallampati score difficult the mask ventilation . Thyromental distance is another predictor used for detecting difficult airway . Normal is thyromental distance is 6.5cm. A thyromental distance of 6 cm or less is predictive of difficult intubation[5].

Interincisor gap or adequate mouth opening ensures easy intubation . Inability to transalate the temperomandibular joint is an indicator of difficult intubation .Similarly cervical vertebral range of motion also predicts difficulty of airway management[6,7].

It has been seen that many a times airway evaluation falls short of intended goal .Of late ultrasound is gaining popularity as a non invasive painless modality for airway assessment. Preoperatively anesthesiologist does the ultrasound examination of the airway at the level of Hyoid bone, at the level of Thyrohyoid membrane and at the level of Suprasternal notch to predict difficult intubation. Various studies have shown that increase in thickness of soft tissue in anterior neck region correlate with increase difficulty in intubation[8,24,52,53,55].

The present study was designed to evaluate utility of ultra sonogram in airway assessment. An attempt has been made to find whether USG assessment can predict difficult airway.

ULTRASOUND ANATOMY OF AIRWAY

Kristensen et al (2013)[22,23,24] has stated that 'the linear high-frequency transducer is most suitable for imaging superficial airway structures (within 2–3 cm from the skin) and that the curved low-frequency transducer, is most suitable for obtaining sagittal and parasagittal views of structures in the submandibular and supraglottic regions, mainly because of its wider field of view[24].

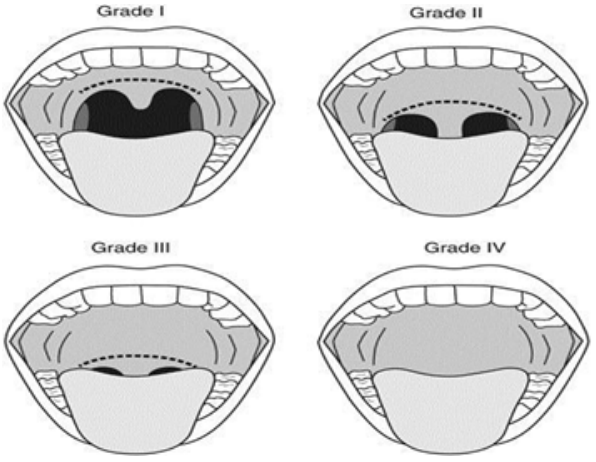
Ultra sonogram appearance of upper airway structures are as follows[25,26,27,28,29]

ANATOMICAL PREDICTORS OF DIFFICULT AIRWAY

1. Mallampatti's test :

The Mallampatti's classification gives us the relationship between the size of the tongue and the size of the pharynx. The patient is seated, head held in neutral position, mouth open as wide as possible and tongue protruded out maximum. Patient should be

instructed not to speak. Classification is done based on the str



MALLAMPATI CLASSIFICATION

In Samson and Young's modification (1987)[4] of the Mallampatti's

classification, a IV class was added.

Mallampatti's I : Soft palate, faucets; uvula, anterior and the posterior pillars are visible.

Mallampatti's II : Soft palate, faucets and uvula are seen.

Mallampatti's III : Soft palate and base of uvula alone are seen.

Mallampatti's IV : Only hard palate seen.

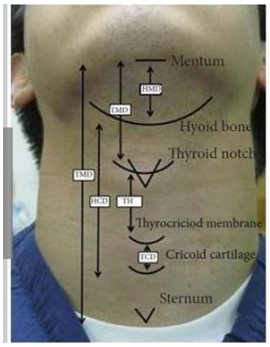
Atlanto occipital joint (AO) extension[43,44,45] :

Ability to maintain Sniffing or Magill position for intubation is assessed by this test.. The patient is asked to hold head erect, facing directly to the front, then he is asked to extend the head maximally and the examiner estimates the angle traversed by the occlusal surface of upper teeth. Measurement can be by simple visual estimate or more accurately with a goniometer. Any reduction in extension is expressed in grades:

Grade I : >35°
Grade II : 22°-34°
Grade III : 12°-21°
Grade IV : < 12°

Normal angle of extension is 35° or more.

Mandibular space



MANDIABULAR SPACE

Thyromental (T-M) distance (Patil's test)[46]:

Thyromental distance as the name suggests is the distance between the thyroid notch and tip of mentum. It is measured after asking the patient to keep the neck fully extended. Thyromental distance gives a rough idea of the relation between larynx and pharynx. It gives us information regarding the alignment of each other when the neck is placed in the intubating position.

- Difficult intubation - distance is < 6 cm in adults;

Less difficult intubation- 6 - 6.5 cms

Easy intubation - > 6.5 cm

Sterno-mental distance[47] :

Sterno mental distance is the distance between suprasternal notch and tip of mentum. It is measured after asking the patient to keep the neck fully extended. Sterno mental distance < 12cms - intubation difficult.

Mandibulo-hyoid distance[48] :

Distance from tip of mandible to hyoid bone is called mandibulo hyoid distance. If the distance is increased then intubation is difficult. Normal is <4 cms.

Inter-incisor distance :

The vertical distance from upper incisor to lower incisors.

Normal is > 4 cm.

<4 cm - difficult airway.

Wilson's scoring system[49]

PARAMETER		0	1	2
Weight (Kg)	<90	90-110	>110	
Head	and Neck	>90 degree	=90	<90
movement				
Inter incisor gap	>5 cm	= 5cm	<5 cms	
Sliding	mandible	>0	>0	<0
beyond	maxillary			
incisors				
Receding mandible	None	Moderate	Severe	
Buck tooth	None	Moderate	Severe	

Table 1

Score 5 or < : Easy laryngoscopy
Score 6 - 7 : Moderate difficulty
Score 8 - 10 : Severe Difficult laryngoscopy

LEMON criteria[50,51]

L	Look	Facial trauma Large incisors Large tongue Beard or moustache
E	Evaluate	Incisor distance - 3 finger
M	Mallampatti's	Score > 3
O	Obstruction	Epiglotitis Peri-tonsillar abscess, Trauma
N	Neck mobility	Limited

Table 2

Difficult intubation- High LEMON score

AIM OF THE STUDY

To assess the usefulness of ultrasound as a non invasive tool in assessing the airway

To assess the use of USG in indentifying difficult airways.

MATERIALS AND METHODS

After obtaining approval from ethical committee and written informed consent a prospective observational study was carried out in 141 patients in Stanley medical college Hospital . Patients

undergoing elective surgery requiring general anesthesia with direct laryngoscopy and endotracheal intubation were included in the study.

Inclusion Criteria:
ASA grade I,II and III
Age 18 to 80 years
Both Sex

Exclusion Criteria:
The patients with mouth opening less than 2 fingers

Edentulous patients

The patients with head and neck anatomical pathologies that might have unpredictable effect on the ultrasound assessment of the airway.

The patients who were not able to extend their neck >30°

Materials required
Ultrasound machine with high frequency (6-12MHz) linear probe transducer.

Ultrasound gel.

Weighing machine

- Measuring scale for height

On the previous day of the surgery the patients were explained about the procedure and after obtaining informed written consent, they were shifted to the ultrasound room in the department of Radiology and the following measurements were made and recorded.

Height: Patient was instructed to stand straight and upright againstthe measuring scale and the height was measured in centimeters.

Weight: Weight of the patient was measured in kilograms using aweighing machine. Ultrasound measurement of thickness of soft tissue in anterior neck
The thickness of anterior neck soft tissues from the skin, was measured at 3different levels.

Level 1: skin to hyoid bone thickness

Level 2: skin to epiglottis level thickness at the thyrohyoid membrane
level

Level 3: skin to tracheal ring thickness at the suprasternal notch level. Patient position: The patient was made to lie down supine with head in

neutral position without a pillow under head. Patient was instructed to keep the mouth closed and to take slow breaths during measurements to minimize errors in recordings due to movements during respiration.

Ultrasound machine(GE LOGIQ F8) control settings: The following controls were set in the ultrasound machine for obtaining the airway assessment measurements and images.

Transducer - Linear High frequency transducer
Axis/Plane - Short axis/Transverse plane
Frequency - 11 Mhz
Depth - 3.0 cms - 4.0 cms

Obtaining measurements: The measurements of anterior neck soft tissues were made at the above mentioned three levels in short axis view.

The hyoid bone was identified as a inverted U shaped hyperechoic structure in the submandibular region. The image was frozen on screen and measurement from skin to midpoint of hyoid bone was taken using the "measure" option in the ultrasound machine.

The Epiglottis was identified in the Thyrohyoid membrane level as a linear hypoechoic structure followed by a hyperechoic shadow. Measurement was taken from skin to epiglottis as mentioned previously.

Tracheal ring was identified in the suprasternal notch level, as a hyperechoic structure followed by acoustic shadowing of air mucosal inter phase. Measurements from skin to tracheal ring were obtained as mentioned previously.

Recording data: The collected data were recorded for further analysis. The patients were then taken back to their wards. The next day morning on

the day of surgery the patients were shifted to their respective operating rooms

and the standard general anesthesia procedure was performed as per the discretion of the attending anesthesiologist who had experience in the field of ANESTHESIOLOGY for at least a minimum of 5 years.

All patients were connected to monitors - ECG, NIBP and PULSE OXIMETER and any additional monitors required as per the type of surgical procedure were kept ready. All patients were premedicated, pre oxygenated, induced and paralyzed using drugs according to the choice of the attending anesthesiologist before intubation. A macintosh blade was used for laryngoscopy. The anesthesiologists were asked to grade the vocal cord view as per Cormack Lehane grading. The best views obtained at the first attempt by the laryngoscopy without any external maneuver were applied was taken as the Cormack Lehane classification.

Cormack Lehane class 1 - visualization of the entire laryngeal aperture

Cormack Lehane class 2 - visualization of parts of the laryngeal aperture or the arytenoids

Cormack Lehane class 3 - visualization of only the epiglottis

Cormack Lehane class 4 - visualization of only the soft palate.

The surgery was carried out and after surgery was over the patients were reversed and extubated. They were observed for half an hour post operatively for full recovery and then the patients were shifted to the post operative wards for further management

Groups
Based on the Cormack Lehane (CL) class noted, patients were grouped into two groups.

Group 1 : Easy laryngoscopy group (CL 1 and CL 2)
Group 2 : Difficult laryngoscopy group (CL 3 and Cl4)

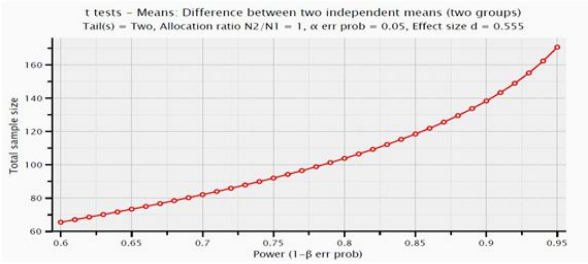
Statistical analysis
To allow for comparisons between the difficult airway and easy airway groups, a two-sided Student's t-test was used.

ROC curve analysis was made for all three levels for obtaining cutoff points that delineates the Group E from Group D, and to assess for the sensitivity and specificity for each measured level.

Association between demographic variables and occurrence of difficult intubation was assessed using Pearson's chi square test.

$p < 0.05$ was considered significant and $p > 0.05$ was not significant

RESULTS



GRAPH-1

For the present study sample size of 141 was determined by power analysis using SPS package version 8. The analysis report is shown in graph 1.

t tests - Means: Difference between two independent means (two groups)

Analysis: A priori: Compute required sample size
Input: Tail(s) = Two
Effect size d = 0.555
α err prob = 0.05
Power (1-β err prob) = 0.90
Allocation ratio N2/N1 = 1
Output: Noncentrality parameter δ = 3.2834243
Critical t = 1.9773035
Df = 138

Total sample size = 140

Actual power = 0.9032896

GROUPING OF CASES

Based on the CL grading, 141 patients under the study were classified into 2 groups.

Group E (Easy airway)
Group D (Difficult airway)

Of the 141 patients 132 are classified into group E and the rest 9 patients were classified in group D.

The observations and results were as follows

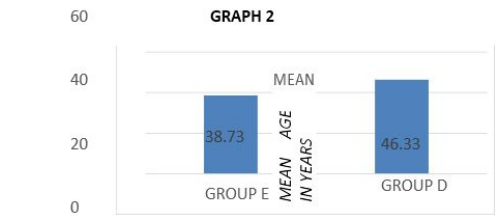
AGE DISTRIBUTION

The mean values of age of patients in easy and difficult intubation is shown in Table 1 (Group E and Group D)

TABLE 3

	NO	MEAN	SD
GROUP E	132	38.73	13.004
GROUP D	9	46.33	10.025

P value =0 .088



P value > 0.05 is not significant

Out of the total 141 cases, the mean age in group E (N = 132) was 38.73 years and the standard deviation was 13.004. Mean age in Group D was 46.33 and the standard deviation was 10.025.These data were computed using students t-test and the P value was be 0.088 which is not statistically significant .

Conclusion: Thus we conclude that the age distribution is insignificant

SEX DISTRIBUTION

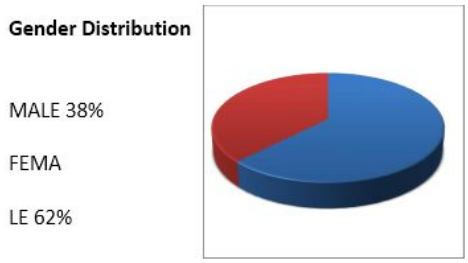
TABLE 4

	GROUP E	GROUP D
FEMALE	81	7
MALE	51	2

P value = 0.82

P value > 0.05 is not significant

GRAPH 3



Out of the total 141 case, 88 cases were females and 53 cases were males. Of the 88 female cases, 81 belonged to Group E and 7 belonged to Group D and out of 53 male cases, 51 belonged to Group E and 2 belonged to Group D. These data were computed using Pearson's Chi Square test and the P value is found to be 0.82, which is not statistically significant.

Conclusion: Thus, we conclude that Sex distribution is not significant

BMI DISTRIBUTION

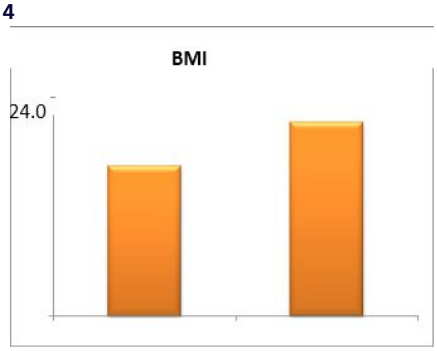
TABLE 5

	NO	MEAN	SD
GROUP E	132	23.7	2.2
GROUP D	9	24	2.46

P Value- 0.779

P Value <0 .05 significant

GRAPH 4



Out of 141 cases in our study , 132 belongs to easy airway group (GROUP E) and 9 cases belongs to difficult airway group(GROUP D). The mean BMI distribution in Group E is 23.7 with standard deviation of 2.197 and the mean BMI distribution in Group D is 24 with standard deviation of 2.466. By using independent t test, the P Value was found to be 0.779 which is statistically not significant.

Conclusion : Thus, we conclude that BMI distribution is statistically not significant

THICKNESS OF ANTERIOR NECK SOFT TISSUE FROM SKIN TO HYOID

BONE

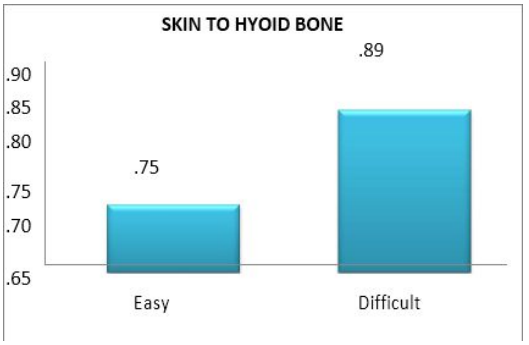
TABLE 6

	NO	MEAN	SD
GROUP E	132	0.75	0.15
GROUP D	9	0.89	0.25

P value = 0.088

P value > 0.05 is not significant

GRAPH 5



Out of 132 cases in Group E , the mean value thickness of anterior neck soft tissue from skin to hyoid bone is 0.75±0.15 .Out of 9 cases in group D , the mean value of thickness from skin to hyoid bone is 0.89±0.25 . By using independent T test from statistical analysis , the P value was calculated to be 0.088 .

Conclusion : There is no statistically significant difference in the thickness of anterior neck soft tissue at the level of hyoid bone.

THICKNESS OF ANTERIOR NECK SOFT TISSUE FROM SKIN TO

EPIGLOTTIS AT THYROHYOID MEMBRANE LEVEL

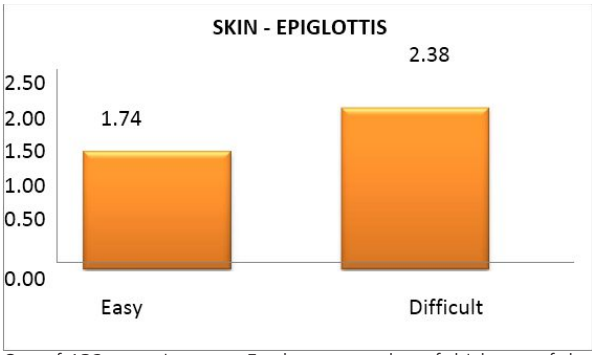
TABLE 7

	NO	MEAN	SD
GROUP E	132	1.74	0.26
GROUP D	9	2.38	0.32

P value = 0.00

P value < 0.05 is significant

GRAPH 6



Out of 132 cases in group E , the mean value of thickness of the anterior neck soft tissue from skin to epiglottis at thyrohyoid membrane level 1.74+-0.26 standard deviation. Out of 9 cases in Group D, the mean value of thickness from skin to epiglottis at thyrohyoid membrane level is 2.38+-0.3182. By using independent t test for statistical analysis, the P value was calculated to be 0.00 which is highly significant .

Conclusion : There is statistically significant difference in the thickness of anterior neck soft tissue at the level of epiglottis in easy and difficult groups

THICKNESS FROM ANTERIOR NECK SOFT TISSUE FROM SKIN

TO TRACHEAL RING AT SUPRASTERNAL NOTCH LEVEL

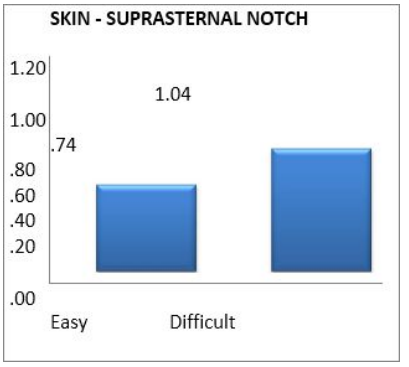
TABLE 8

	NO	MEAN	SD
GROUP E	132	0.735	0.126
GROUP D	9	1.0389	0.536

P value = 0.128

P value < 0.05 is significant

GRAPH 7



Out of the 132 cases in group E , the mean value of thickness of the anterior neck soft tissue from skin to tracheal ring at suprasternal notch level is 0.73± 0.12371. Out of the 9 cases in Group D , the mean thickness from skin to tracheal ring at suprasternal notch level is 1.03+_0.53622 standard deviation

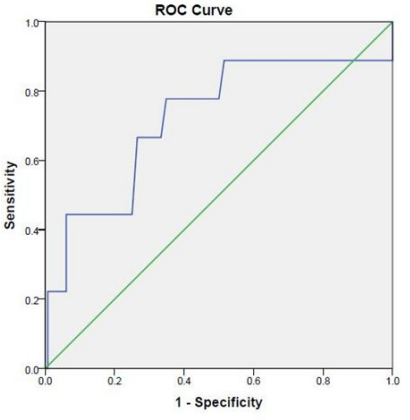
By using independent . test for statistical analysis , the P value was calculated 0.128 , which is statistically not significant .

Conclusion : There is no statistically significant difference in the thickness of anterior neck soft tissue at the level of suprasternal notch in easy and difficult groups

ROC CURVE ANALYSIS FOR CUT OFF POINTS

ANTERIOR NECK SOFT TISSUE THICKNESS FROM SKIN TO HYOID

BONE LEVEL



Graph 8

Based on ROC curve the cutoff point that delineates the Group E and Group D for hyoid level is 0.78 cms . And area under the curve is 0.722.

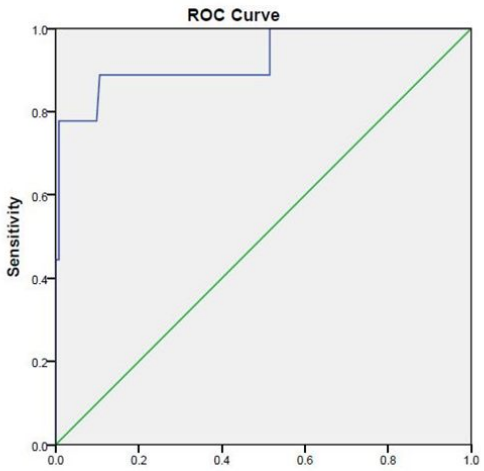
Out of the total 141 cases in the study the number of cases above the cutoff point is 53 and the number of cases less than the cutoff point is 88. This states that based on the Cutoff point of hyoid bone , 53 cases are predicted to be difficultintubation but based on Cormack Lehane grading , only 9 cases were categorized as Group D . Similarly 88 cases were predicted as Easy intubation group based on cutoff point by hyoid bone. But based on Cormack Lehane grading 132 cases belonged to Group E .

Based on these data the sensitivity and specificity were calculated for Anterior neck soft tissue thickness at hyoid level .

Cutoff point is 0.78

Area under the curve is 0.722 Sensitivity is 66.7% sensitive. Specificity is 66.7% specific.

THICKNESS OF ANTERIOR NECK SOFT TISSUE FROM SKIN TO EPIGLOTTIS AT THYROHYOID MEMBRANE LEVEL



Graph 9

Based on ROC curve the cutoff point that delineates the Group E and Group D for Thyrohyoid membrane level is 2.08cms. Area under the curve is 0.929.

Out of the total 141 cases in the study the number of cases above the cutoff point is 24 and the number of cases less than the cutoff point is 117. This states that based on the Cutoff point of hyoid bone, 24 cases are predicted to be difficult intubation but based on Cormack Lehane grading, only 9 cases were categorized as Group D .

Similarly 117 cases were predicted as Easy intubation group based on cutoff point by hyoid bone. But based on Cormack Lehane grading 132 cases belonged to Group E .

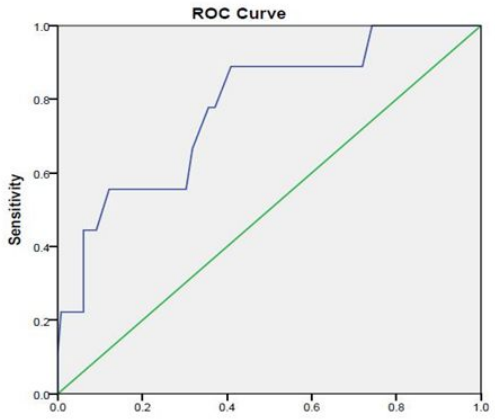
Based on these data the sensitivity and specificity were calculated for Anterior neck soft tissue thickness at Thyrohyoid membrane level (Epiglottis level)

Cutoff point is 2.08cms

Area under the curve is 0.929 Sensitivity is 88.9% sensitive. Specificity is 88.6% specific.

THICKNESS OF ANTERIOR NECK SOFT TISSUE FROM SKIN TO TRACHAEL

RING AT SUPRASTERNAL NOTCH LEVEL



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