"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"

By

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Dissertation

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With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON OF THYROMENTAL HEIGHT TEST WITH RATIO OF HEIGHT TO THYROMENTAL DISTANCE, THYROMENTAL DISTANCE AND MODIFIED MALLAMPATTI TEST IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

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LIST OF ABBREVIATIONS USED

ASA	-	American society of Anesthesiologists
AUC	-	Area Under Curve
BMI	-	Body mass index
Bpm	-	Beats per minute
BURP	-	Backward, Upward & Rightward Pressure
CBC	-	Complete Blood Count
CI	-	Confidence interval
CICV	-	Cannot Intubate and Cannot Ventilate
C-L	-	Cormack-Lehane
cm	-	Centimeter
Cpm	-	Cycles per minute
DVL	-	Difficult Visualization of Larynx
FBS	-	Fasting Blood Sugar
GA	-	General Anaesthesia
HMD	-	Hyomental Distance
HNM	-	Head & Neck Movement
IIG	-	Inter-Incisor Gap

kg - Kilogram

MCLS - Modified Cormack Lehane Scoring

ML - Mandibular Length

Mm - Millimeter

MMT - Modified Mallampati Test

Nc/TMH - Ratio of Neck circumference to Thyromental Height

NPV - Negative Predictive Value

PPV - Positive Predictive Value

RHTMD - Ratio of Height to Thyromental Distance

ROC - Receiver Operator Characteristic curve

SD - Standard deviation

SMD - Sternomental Distance

TMHT - Thyromental Height Test

TMD - Thyromental Distance

TSD - Thyrosternal Distance

ULBT - Upper Lip Bite Test

ABSTRACT

TITLE:

"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"

BACKGROUND:

Preoperative airway assessment to identify patients with difficult airway is considered crucial for anaesthesiologists. Incidence of difficult airway is projected in the range of 1.5% - 20%. Ineffective management of difficult airway is one of the important causes of anaesthesia related morbidity and mortality. Several preoperative airway predictive tests have been used alone or in combinations to predict difficult airway but none of them has been considered as the single best predictor of difficult airway. Thyromental Height is a relatively new airway assessment test that has been reported to have a better predictive accuracy of difficult airway.

OBJECTIVES:

We conducted this study to validate the best predictor of difficult airway by comparing Thyromental Height (TMHT) with other recognized airway assessment tests such as Thyromental distance (TMD), Modified Mallampati Test (MMT) and Ratio of Height to Thyromental distance (RHTMD) and to evaluate the predictive accuracy of Thyromental height.

METHODS:

100 patients belonging to either gender of age between 18 and 70 years undergoing elective surgery under General Anaesthesia requiring oral endotracheal intubation were included in this study after obtaining Ethical committee approval and written informed consent.

Preoperative assessment of patients' airway was done on the day before surgery. GA was induced following standard institutional protocol. Laryngoscopic view was graded by Modified Cormack-Lehane Scoring system. The cut-off value for TMHT, TMD and RHTMD were determined using ROC curve. Validity indices of all four airway assessment tests were calculated using standard formulae.

RESULTS:

Incidence of difficult intubation was 29%. The cut-off value for TMHT, TMD and RHTMD were 5.8 cm, 6.7 cm and 20.5 respectively. The sensitivity, specificity, PPV and NPV of TMHT were 92.96%, 31.03%, 76.19% and 56.5% respectively. Highest sensitivity and Predictive accuracy were observed with TMHT as compared with TMD, MMT and RHTMD.

CONCLUSION:

Thyromental Height can be considered a fairly reliable predictor of difficult airway and could be used to identify patients with difficult airway, although it cannot be used as a standalone test to predict difficult airway.

KEYWORDS:

Difficult Airway, Airway predictive tests, Thyromental Height.

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INTRODUCTION

Preoperative assessment of airway to identify patients who are likely to have difficult airway is considered crucial for anaesthesiologists. It is estimated that about 30% - 40% anaesthetic deaths are attributable to inefficient management of difficult airway. The incidence of difficult airway is projected in the range of 1.5% - 20%. Substandard management of difficult airway is one of the major causes of anaesthesia related morbidity and mortality. Assessment of airway is the first stage in devising an airway management plan. It is still uncertain which anatomical landmark or indices are the best predictors, despite the availability of a multitude of preoperative bedside airway assessment tests.

Thyromental height test (TMHT) is a relatively new preoperative airway assessment test used to predict difficult airway. This test is not limited by head extension because it is independent of patient's cervical spine mobility, co-operation and dentition. Thyromental height is a more objective evaluation that is less susceptible to inter-observer variability. Variety of preoperative bedside airway predictor tests such as Thyromental Distance (TMD), Modified Mallampati Test (MMT), Sternomental Distance (SMD) and Ratio of Height to Thyromental Distance (RHTMD) have been employed as a standalone test or combination of tests in order to predict difficult airway. However there is no single test or combination of tests that can accurately predict the difficult airway.

This study is undertaken with the aim of comparing the predictive accuracy of Thyromental Height Test (TMHT) with other airway assessment tests such as Thyromental Distance (TMD), Modified Mallampati Test (MMT) and Ratio of Height to Thyromental Distance (RHTMD) for predicting difficult airway and to quantify the validity indices such as sensitivity, specificity, Positive predictive value (PPV) and Negative predictive value (NPV) for Thyromental Height Test (TMHT) and compare it with the other airway predictive tests.

OBJECTIVES OF THE STUDY

a) To validate the best predictor of difficult airway by comparing Thyromental Height (TMHT) with other recognized airway assessment tests such as Thyromental distance (TMD), Modified Mallampati Test (MMT) and Ratio of Height to Thyromental distance (RHTMD).

b) To determine the predictive accuracy of Thyromental Height (TMHT) by quantifying the sensitivity, specificity, Positive predictive value (PPV) and Negative predictive value (NPV).

REVIEW OF LITERATURE

Unanticipated difficult airway and failed intubation in operation theatre and emergency department is one of the important causes of anaesthesia related patients' morbidity and mortality.[5] Several indices have been suggested to identify patients with possible difficult airway before induction of general anaesthesia.[6]

Mallampati SR and others did an observational study in 1985 on the clinical signs to predict difficult tracheal intubation and presented a relatively simple grading system which involves preoperative ability to visualize faucial pillars, soft palate and base of uvula as a means to predict the degree of difficulty in laryngeal exposure. This study supported the hypothesis that difficult laryngeal visualization can be predicted in majority of cases by eliciting the visibility of faucial pillars and uvula. Mallampati test is the most extensively used preoperative airway predictive tool worldwide to predict difficult airway because it is easy to perform and a very convenient bedside airway predictive test.[7]

Samsoon G.L.T and Young J.R.B conducted a retrospective study in 1987 to establish the relation between degree of difficult intubation and anatomy of oropharynx in the same patient who had previous history of difficult intubation or failed intubation. They carried out airway assessment based on the method which was described by Mallampati et al. Then it was compared to the laryngoscopic view which was graded by Cormack-Lehane scoring system. They concluded their study stating that Mallampati test could be used to screen patients to identify those who are at risk for difficult laryngoscopy. They added that patients with grades III and IV constitute for difficult intubation whereas grades I and II constitute easy visualization of larynx.[12]

Butler P.J and Dhara S.S conducted an observational study in 1992 on South East Asian population to determine the likelihood of difficult laryngoscopy by Thyromental distance and

Modified Mallampati test by comparing with Cormack Lehane Scoring system. They found the predictive airway tests to be unreliable as their study predicted less than two in three difficult laryngoscopies and produced high false positives. They concluded that among the two airway predictors studied, Thyromental distance had high sensitivity whereas Mallampati test showed high specificity and high positive predictive value.[1]

Safavi M and others did an observational study in 2011, comparing the Ratio of Patient's height to Thyromental Distance (RHTMD) with Modified Mallampati Test (MMT) and Upper Lip Bite Test (ULBT) in assessing difficult airway and concluded that both RHTMD and ULBT are comparable in assessment of difficult airway in general population and both are useful bedside screening tests. But when compared with RHTMD and ULBT, MMT is a poor predictor of difficult airway when used alone or in combination with other bedside screening tests.**[8]**

Schmitt HJ and others did a prospective observational study in 2002 to evaluate the hypothesis that Ratio of the patient's height to Thyromental distance (RHTMD) would improve the accuracy of predicting difficult airway compared with Thyromental Distance (TMD) and stated that a ratio of more than or equal to 25 for RHTMD was found to be the optimal cutoff value to predict difficult airway. They concluded the study stating that RHTMD can be used instead of TMD in order to predict difficult airway as it had a greater specificity than TMD which was significant though the sensitivity of both TMD and RHTMD were found to be same. They further stated that since RHTMD was studied only in the Caucasians, it cannot be supposed that these results would be applicable to other ethnic groups.**[6]**

Shah PJ and others did a prospective observational study in 2013 on the predictive value of Upper Lip Bite Test (ULBT) and Ratio of height to Thyromental Distance (RHTMD) compared to other multivariate airway assessment tests for assessment of difficult airway in apparently normal patients and found that both ULBT and RHTMD had highest sensitivity, specificity, PPV and NPV compared to Thyromental Distance (TMD), Modified Mallampati test (MMT), Inter Incisor Gap (IIG) and Head & Neck Movement (HNM). They concluded the study stating

that ULBT is a better screening test for predicting difficult airway in general population and RHTMD can be used as another alternative airway predictor in combination with ULBT.[9]

Shobha D and others did an observational study in 2018 comparing the Upper Lip Bite Test (ULBT) and Ratio of Height to Thyromental distance (RHTMD) with other bedside screening tests for assessing the likelihood of difficult laryngoscopy and found that ULBT and RHTMD had highest sensitivity, specificity, Positive and Negative predictive values when compared to other airway predictive tests in predicting difficult airway. The study concluded that both ULBT & RHTMD may be used as simple bedside airway assessment tools for prediction of difficult airway.[5]

Kaniyil S and others did a comparative observational study in 2018 on the Ratio of height to thyromental distance (RHTMD) as a screening test for identifying difficult airway compared with Thyromental distance (TMD), Modified Mallampati test (MMT) and Upper Lip Bite test (ULBT). They found that RHTMD is a single best screening test for predicting difficult airway and combining other airway predictive tests have higher sensitivity and specificity with better accuracy. They concluded the study stating that the airway predictor indices should be used in a combination to assess preoperative difficult airway in adult patients.[3]

Etezadi F and others did an observational study in 2013 on Thyromental Height Test (TMHT) as a newer bedside screening test for prediction of difficult airway and concluded that TMHT was observed to be a better predictor of difficult airway than the existing airway predictors and can be regarded as a single reliable predictor of difficult laryngoscopy.[2]

Rao KV and others did an observational study in 2018 on the validity of Thyromental height (TMHT) as a predictor of difficult airway. The study was a prospective evaluation comparing TMHT with modified Mallampati score, Inter-incisor gap, Thyromental distance, neck circumference and neck extension. The study results showed that TMHT had highest sensitivity, specificity and highest PPV and NPV when compared with other airway predictors.

The study was concluded stating that TMHT appears as a promising single anatomical measure to predict difficult airway.[4]

Koh L.K.D and others conducted an observational study in 2002 on the use of modified Cormack-Lehane scoring system (MCLS) of laryngoscopic views. They studied the distribution of different grades of MCLS, predictive factors and rate of difficult laryngoscopy and its association with difficult intubation. They concluded the study saying that Mallampati classification and thyromental distance (TMD) were associated with lower predictive values for difficult laryngoscopy and that MCLS better emphasizes on the difficulty experienced during laryngoscopy than the original Cormack-Lehane grading.[10]

Deepak T.S and Vikas K.N conducted a prospective, observational study in 2016 to evaluate different grades of modified Cormack-Lehane scoring system in Indian population and to assess the predictive accuracy of preoperative airway predictors in predicting difficult intubation by comparing with modified Cormack-Lehane grading. They used Modified Mallampati test and Thyromental distance to predict difficult airway preoperatively which was compared with modified Cormack-Lehane grading. They described grades I and 2A as easy laryngeal visualization and grades 2B, 3 & 4 as difficult visualization of larynx (DVL). They concluded their study stating that Mallampati classification had better predictive value for grades 2B, 3 & 4 of modified Cormack-Lehane scoring system because of its high diagnostic accuracy.[11]

Wang Bin and others conducted an observational study in 2018 to investigate the accuracy of Thyromental Distance(TMD) measurement and to establish the difference in error rate between male and female population by comparing TMD measurement using surface landmark technique and measurement based on ultrasound location of thyroid cartilage. They found that the TMD measurement error rate was high in females because of relative difficulty in locating the thyroid cartilage prominence among females. Study was concluded stating that using ultrasound localization of thyroid cartilage, TMD may be accurately measured and error

rate between males and females can be greatly reduced and added that prediction value of difficult airway by Thyromental distance will also increase when ultrasound is used.[13]

Attar A and Gandhi R did a prospective, observational study in 2019 in Indian population to assess the best predictor of difficult airway amongst Upper Lip Bite Test (ULBT), Hyomental distance (HMD), Thyromental distance (TMD), Thyrosternal distance (TSD) and Mandibular Length (ML). All the above mentioned tests were compared with Cormack-Lehane scoring system which was taken as a gold standard test. The study was concluded stating that Thyromental distance was the most sensitive airway predictor but none of the tests were a foolproof and could not be used as a reliable screening test. They further added that a negative test would not rule out the possibility of difficult airway and one should be prepared with difficult airway trolley in situations where unexpected difficult airway is encountered.[14]

BASIC SCIENCES

ANATOMY OF THE AIRWAY

The term “Airway” refers to the extra pulmonary air passage and it is composed of the nasopharynx, oropharynx and laryngopharynx, larynx, trachea and bronchi. The functions of the airway in an awake person includes those of filtration ofinspired air, conditioning of the ambient air, humidification and conduction of air to and from the lungs for the process of gaseous exchange.

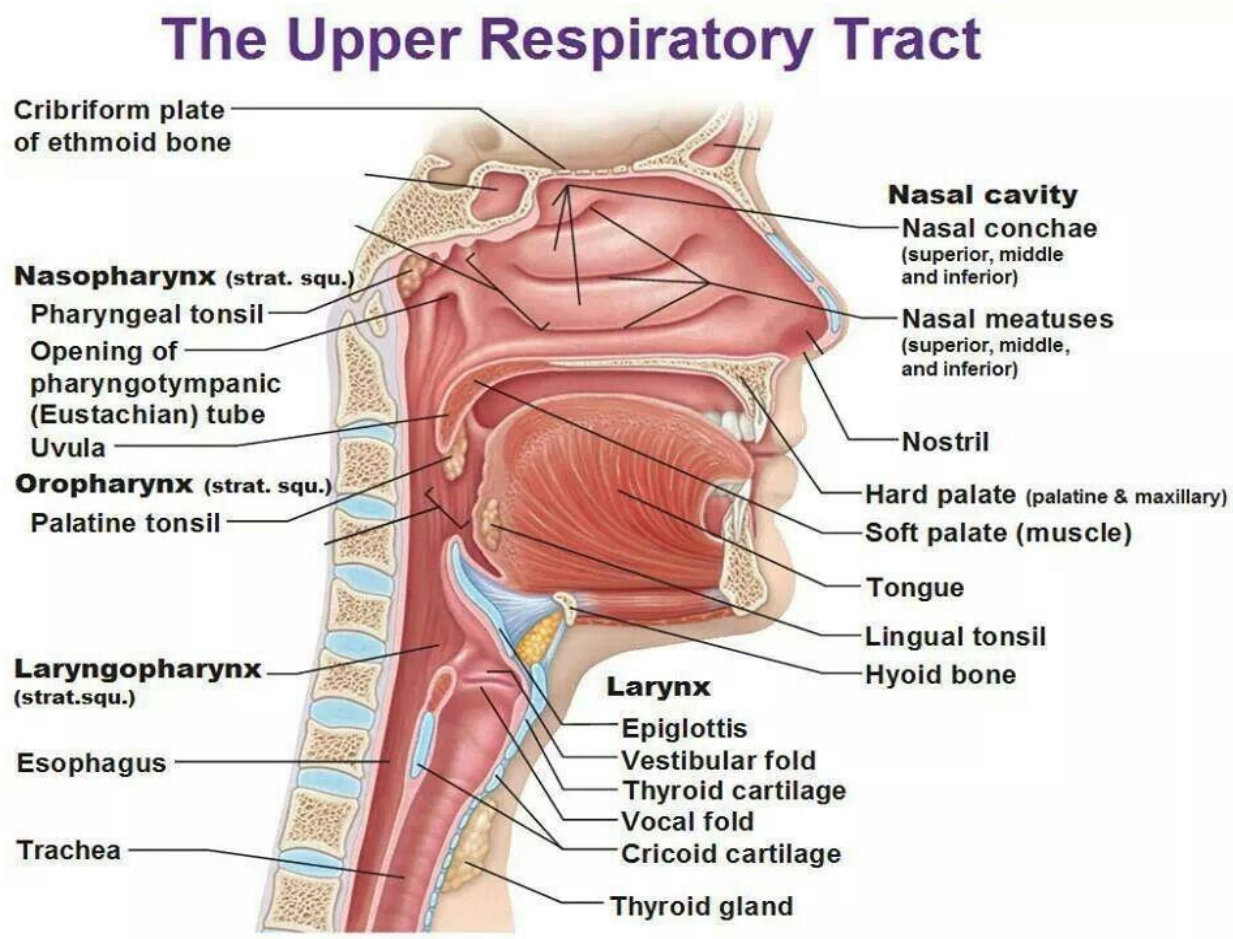
Anatomically, the airway can be classified into an upper airway and lower airway. The upper airway is composed of the nose and nasal passages, the nasopharynx, mouth and the oropharynx. The lower airway is composed of the larynx, trachea, bronchi, bronchial tree and the alveoli.

During the process of induction and maintenance of anaesthesia, the airway is in a passive state of function due to the suppression of the nervous system which controls the vital respiratory functions. The anaesthesiologist should possess the ability of ventilating the patient either by bag and mask method or intubate, if necessary, when the patient is at this state. In order to assess and anticipate a situation of difficult airway and to formulate a plan of safety for the patient, he or she should be well versed with the anatomy of the airway, its applications and the various methods of airway assessment.

NOSE

Nose begins from nares posteriorly to the nasopharynx for 10 to 14cm and two nasal fossae are separated in the midline through the septum which is formed by cartilages and bony parts. It aids in filtration, respiration, humidification of gas, olfaction and it aids in phonation as well.

FIGURE 1



MOUTH

The mouth consists of the oral cavity and the vestibule. The cavity communicates with the vestibule through the angle of the mouth. The vestibule is composed of the gums and teeth within and of the cheeks and lips on the outside of it. The cavity of the mouth is bounded above by the soft and hard palate, anteriorly by theteeth and alveolar arch, posteriorly by the oropharyngeal isthmus and inferiorly by the anterior two thirds of the tongue below.

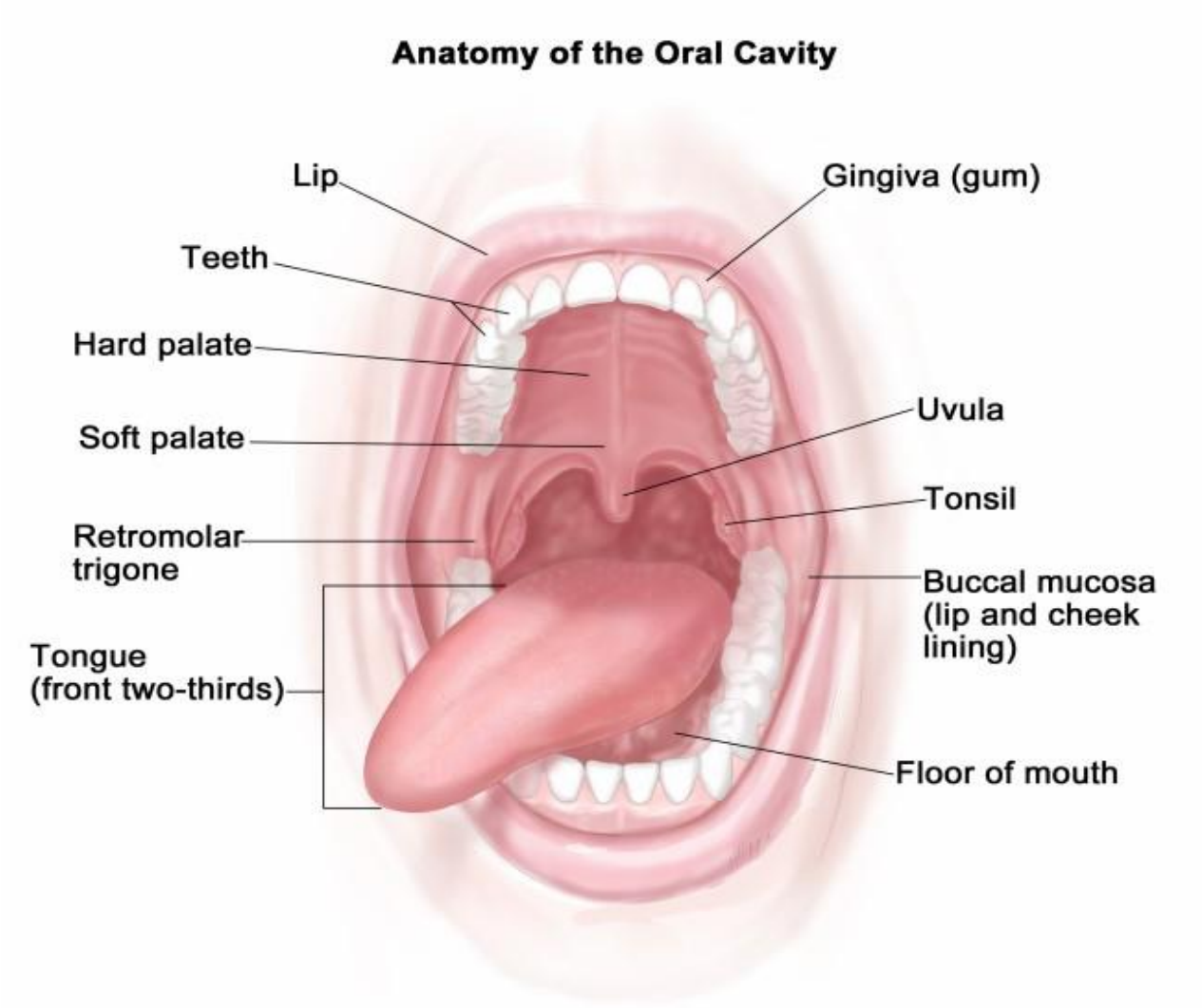
PALATE

The palate is composed of two parts namely the hard palate and the soft palate. Hard palate is made up of the palatine process of maxilla and the horizontal plates of the palatine bones. Soft palate hangs like a curtain from the posterior edge of the hard palate.

PHARYNX

Pharynx begins from base of skull and ends anteriorly to cricoid cartilage and posteriorly to inferior border of sixth cervical vertebra. It measures 12 to 15cm in length.

FIGURE 2



LARYNX

Larynx is present opposite to the cervical vertebra where it extends from third to sixth cervical vertebra in adults. It is made of cartilages, ligaments and muscles where every structure has an important role. Larynx is made of 9 cartilages, 3 paired and 3 unpaired cartilages.

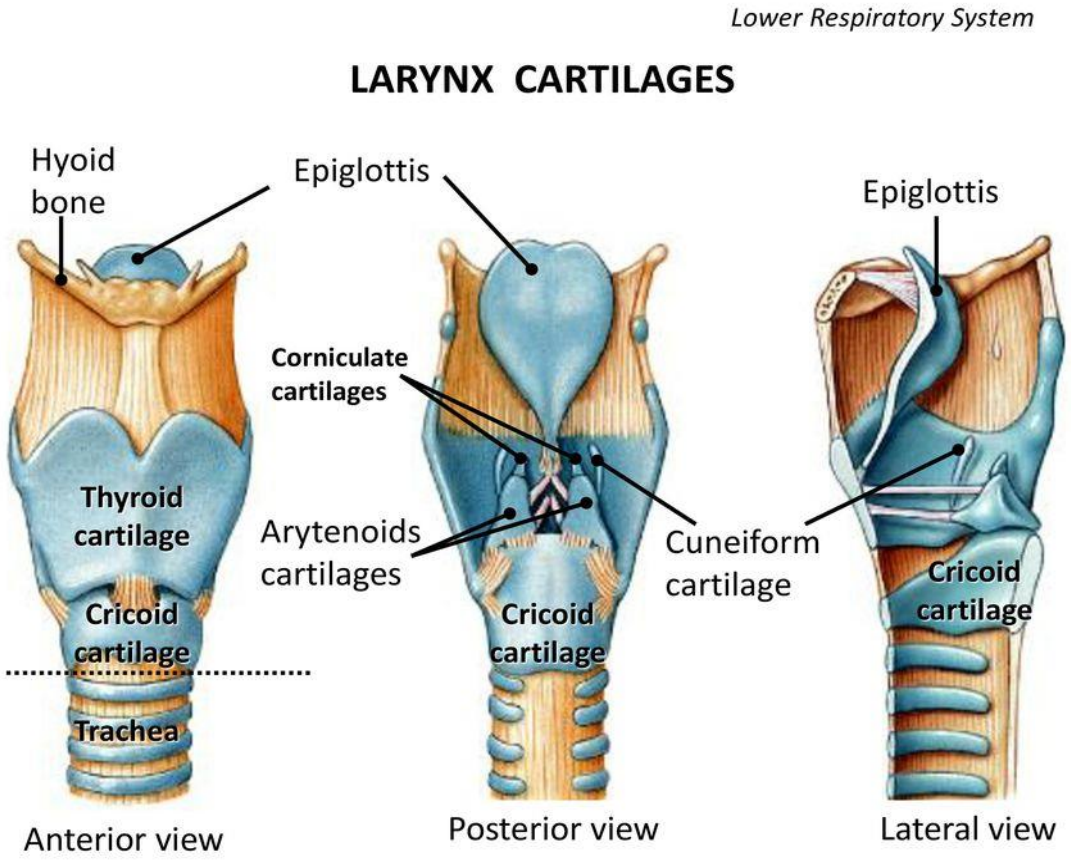
The 3 unpaired cartilages include

1. Thyroid
2. Cricoid
3. Epiglottis

The 3 paired cartilages are

1. Arytenoids
2. Corniculate
3. Cuneiform

FIGURE 3



The laryngeal ligaments are divided into two types namely

- Extrinsic ligaments
- Intrinsic ligaments

TABLE 1: Ligaments of Larynx

EXTRINSIC LIGAMENTS	INTRINSIC LIGAMENTS
Thyrohyoid membrane and ligaments	Elastic membrane
Cricothyroid membrane and ligaments	Quadrangular membrane
Cricotracheal ligament	Median cricothyroid ligament
Epiglottis	Thyroepiglottic ligament
	Vocal ligament

The muscular skeleton of larynx consists of

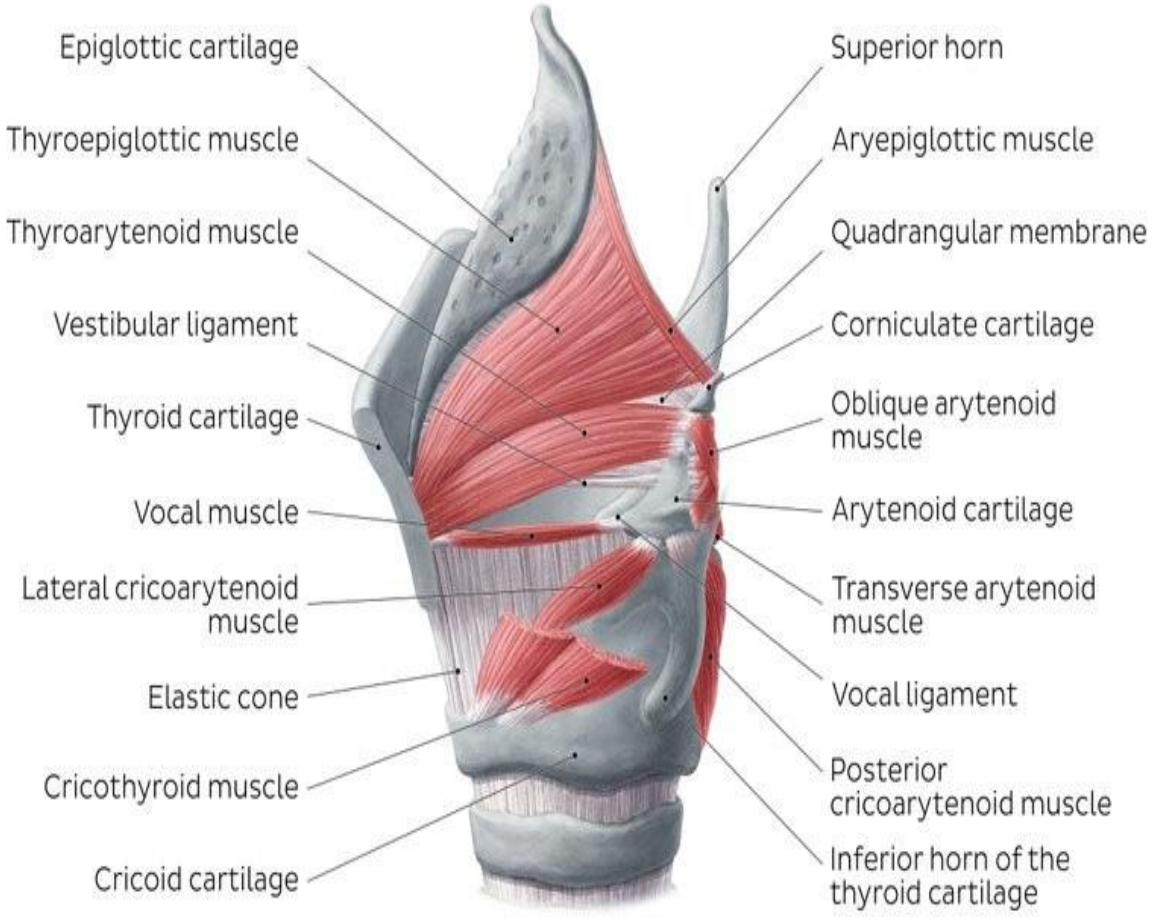
- The Suprahyoid muscles
    1. Geniohyoid
    2. Mylohyoid
    3. Stylohyoid
    4. Digastric
- The longitudinal muscles
    1. Palatopharyngeus
    2. Salpingopharyngeus
    3. Stylopharyngeus
- The Infrahyoid muscles
    1. Sternohyoid
    2. Sternothyroid
    3. Omohyoid

THE INLET OF LARYNX

Laryngeal cavity begins from epiglottis and extends till subglottis. The inlet of the larynx faces backward and upward and opens into the laryngeal part of the pharynx. The boundaries for thelaryngeal inlet are as follows:

- Anteriorly: The upper margin of the epiglottis
- Posteriorly: Arytenoid cartilages
- Laterally: Aryepiglottic folds
- Inferiorly: Arytenoid cartilages

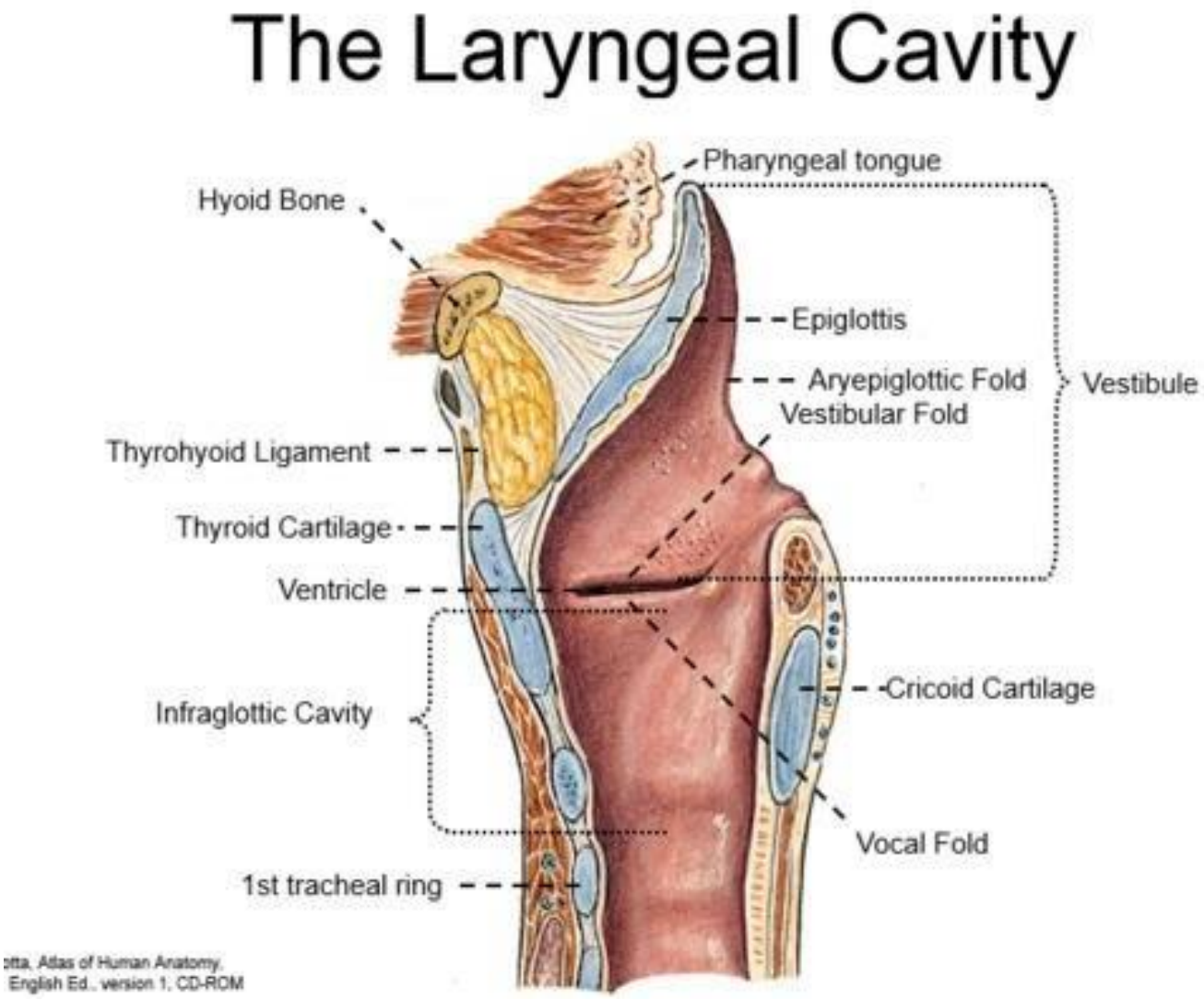
FIGURE 4



THE CAVITY OF LARYNX

The cavity of the larynx begins at the laryngeal inlet andends at the cricoid cartilage at its lower border. It gradually narrows downwards up to the region of the vestibular folds (Rima vestibuli) and it becomes the narrowest at the region of the vocal folds (Rima glottidis).

FIGURE 5



BLOOD SUPPLY OF LARYNX

1. Arteries:

- Upper half of larynx: Superior laryngeal artery, branch of superiorthyroid artery
- Lower half of larynx: Inferior laryngeal artery, branch of inferiorthyroid artery

2. Veins:

They accompany the corresponding arteries.

3. Lymphatics:

The lymphatic vessels drain into the deep cervical lymph nodes.

4. Nerve supply:

- **Pharynx:**

  Pharynx is innervated by the cranial nerves 7^{th}, 9^{th}, 10^{th} and 12^{th}. The motor & sensory innervation to most of the pharynx other than nasopharynx is innervated by the pharyngeal plexus.

Pharyngeal plexus is present above the middle pharyngeal constrictor which is made by:

1. The Pharyngeal branches which arise from the glossopharyngeal nerve.
2. The Pharyngeal branches which arise from the vagus nerve.
3. Branches which arise from the external laryngeal nerve.
4. There are Sympathetic nerve fibers which arise from the superior cervical ganglion.

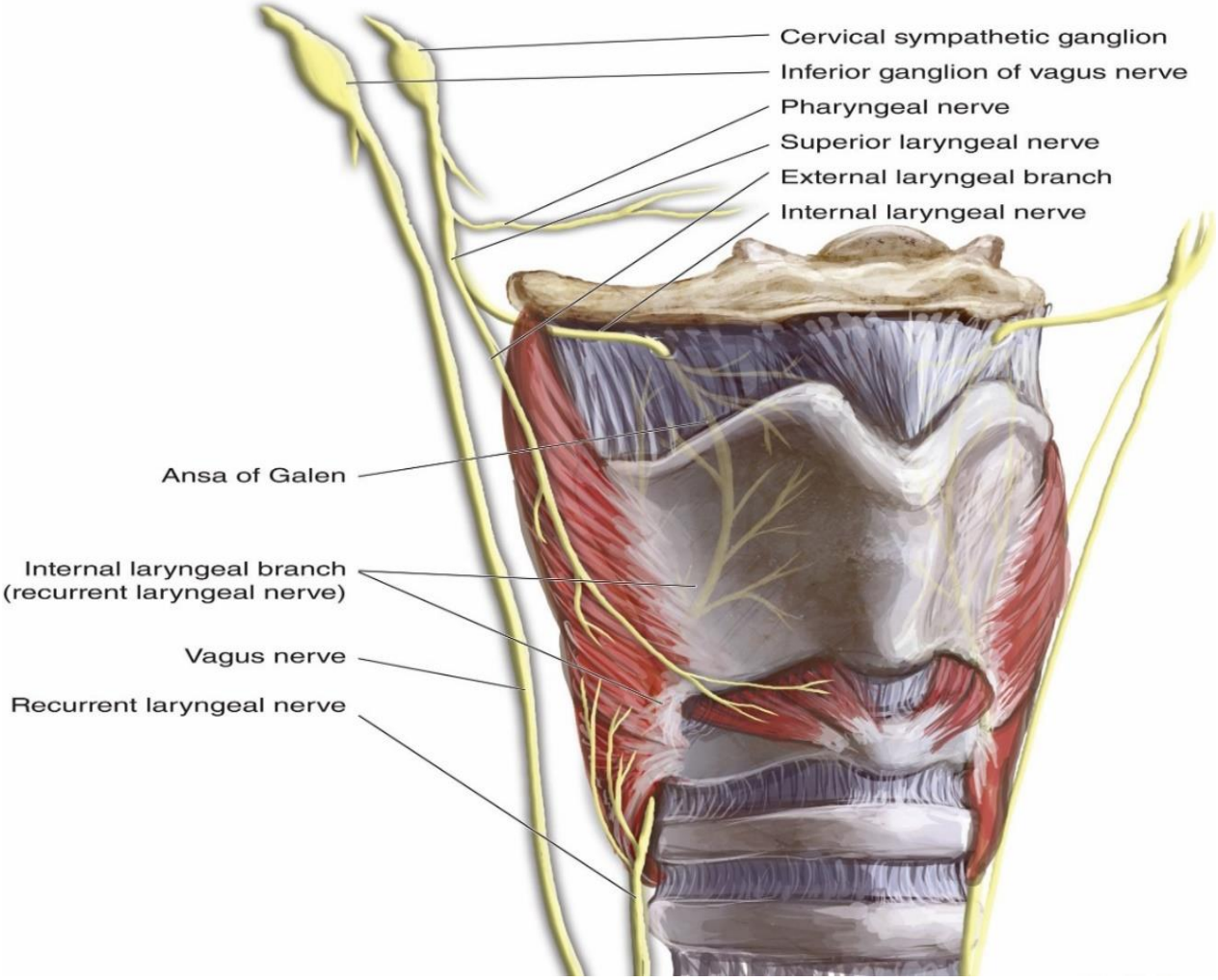
Sensory Innervations:

Pharynx is supplied with sensory innervation from the glossopharyngeal nerve. The superior & anterior part of nasopharynx is supplied by the maxillary nerve whereas the inferior aspect of the laryngo-pharynx is supplied by internal branch of the vagus nerve.

Motor Innervations:

All the muscles of pharynx are supplied by the vagus nerve, apart from the stylopharyngeus muscle, which is supplied by the glossopharyngeal nerve.

FIGURE 6



- **Larynx:**

Larynx is innervated by the vagus nerve where it gives branches as

- Superior laryngeal nerve branch.
- Recurrent laryngeal nerve branch.

Superior laryngeal nerve:

- The internal division of superior laryngeal nerve supplies the epiglottis, the base of tongue, supra-glottic mucosa, thyro-epiglottic joint & crico-thyroid joint.

- The external division of superior laryngeal nerve gives sensory innervations to anterior subglottic mucosa and motor innervations to crico-thyroid muscle which is adductor, tensor.

Recurrent laryngeal nerve:

- Provides sensory supply to the sub-glottic mucosa & muscle spindles. It also provides motor supply to thyro-arytenoid, lateral crico-arytenoid, inter arytenoids & posterior crico-arytenoid

Sensory Innervations:

Above the vocal cords: Internal laryngeal nerve, branch of superior laryngeal nerve which in turn is the branch of vagus nerve.

Below the vocal cords: Recurrent laryngeal nerve, branch of the vagus nerve.

Motor Innervations:

All intrinsic muscles of the larynx are supplied by the recurrent laryngeal nerve except for cricothyroid muscle.

Cricothyroid muscle is supplied by the external laryngeal nerve which in turn is a branch of the superior laryngeal branch of Vagus nerve.

LARYNGOSCOPIC ANATOMY

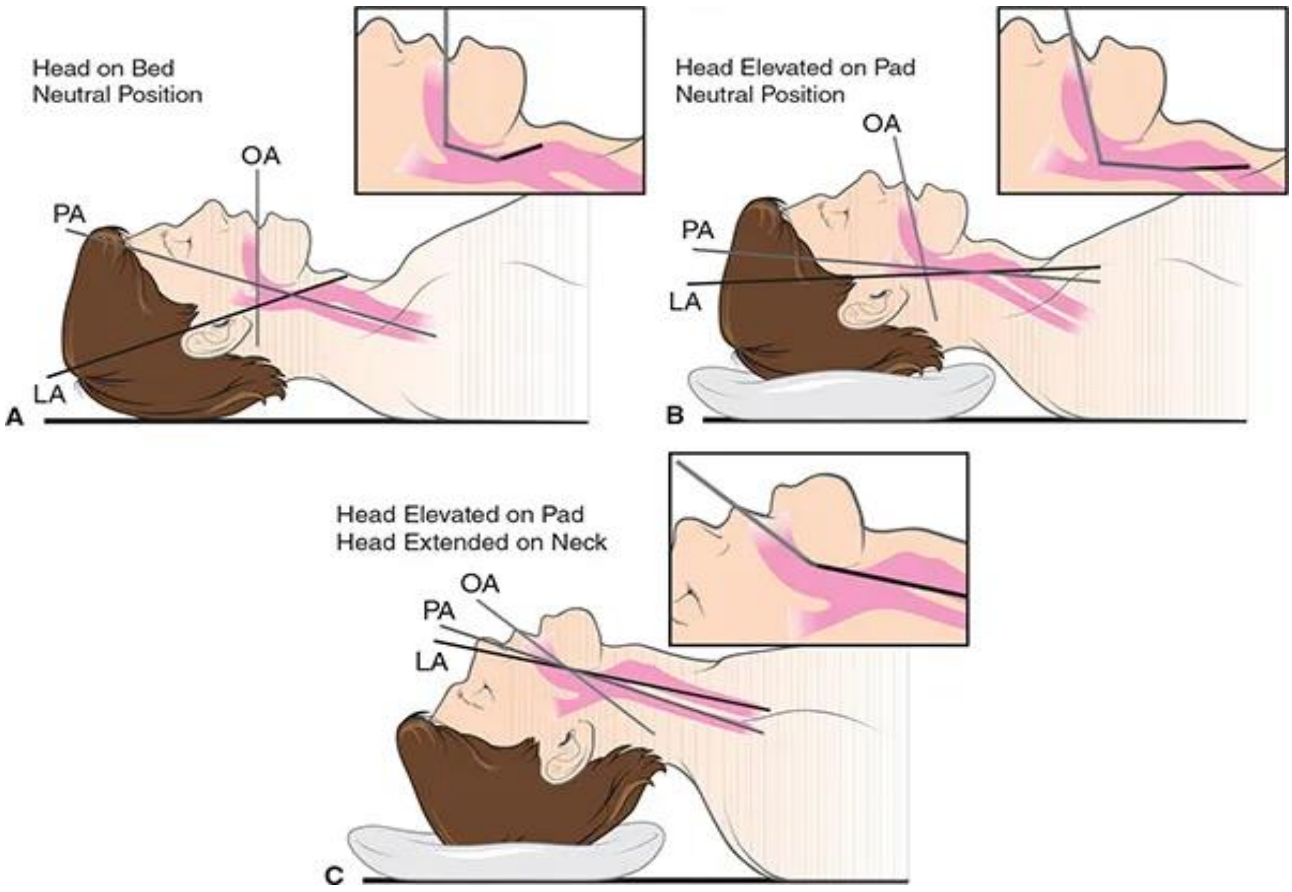
It is essential to get the mouth, the oropharynx and the larynx into oneplane in order to view the vocal cords during direct laryngoscopy and to proceed with intubation. Elevation of the head for about 10cm with a pillow under the occiput, making sure that the shoulders are on the table will cause thelaryngeal and the pharyngeal axis to fall in a straight line. A straight line is created from the incisors till the glottis along with the shortest distance when the patient's neck is flexed at the lower cervical spine and extended at the atlanto-occipital joint. This position is referred to as the sniffing position.

A: Anatomical neutral position. The oral axis (OA), pharyngeal axis (PA), and laryngeal axis (LA) are not aligned.

B: Head, still in neutral position, has been lifted by a pillow flexing the lower cervical spine and aligning the PA and LA.

C: The head has been extended on the cervical spine, aligning the OA with the PA and LA, creating the optimum sniffing position for intubation.

FIGURE 7



DIFFICULT LARYNGOSCOPY / INTUBATION

The definition of difficult airway by the ASA task force is as follows:

"The clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with mask ventilation or difficulty with tracheal intubation or both". It also involves a complex association between patient related factors, skills and preference of anaesthesiologist and the clinical scenario.

DEFINITION OF DIFFICULT MASK VENTILATION

The definition of difficult mask ventilation as quoted by the ASA task force:

"A situation in which an unassisted anaesthesiologist is unable to maintain the oxygen saturation above 90% using 100% oxygen and positive pressure mask ventilation in a patient whose oxygen saturation was greater than 90% before anaesthetic intervention".

"A situation in which an unassisted anaesthesiologist is unable to prevent or reverse the signs of inadequate ventilation during positive pressure mask ventilation".

DEFINITION OF DIFFICULT INTUBATION

The definition of difficult intubation as given by the ASA task force is:

"A situation in which a proper insertion of the tracheal tube with conventional laryngoscopy requires more than three attempts or more than ten minutes".

- **MODIFIED MALLAMPATI TEST (MMT)**:

It is assessed by asking the patient to sit and open his/her mouth maximally and to protrude the tongue without phonation. Examiner will stand at the foot end at the eye level of the patient and using a pen torch oropharynx is visualized.

It is graded as follows:

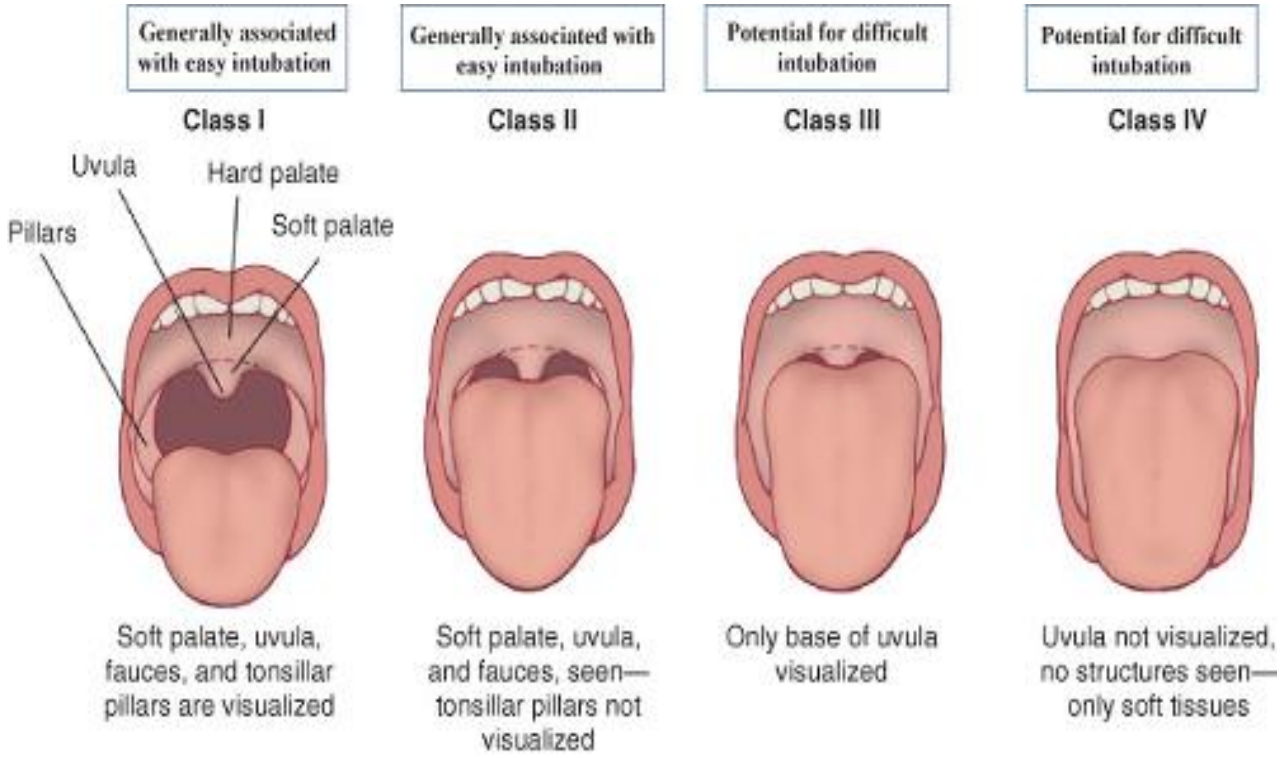
TABLE 2: Modified Mallampati Test Classification

GRADE	OROPHARYNGEAL STRUCTURES VISIBLE
I	Soft palate, fauces, uvula, anterior and posterior tonsillar pillars.
II	Soft palate, fauces, uvula.
III	Soft palate, base of uvula.
IV	Only hard palate.

Grades I and II constitute easy laryngoscopy and intubation.

Grades III and IV are considered as risk factor for difficult airway.[12]

FIGURE 8



- **MODIFIED CORMACK-LEHANE SCORING SYSTEM :**

  This grading is considered gold standard and it is assessed intraoperatively after direct laryngoscopy. The grading is done based on the structures visualized during laryngoscopy.

  It is graded as follows:

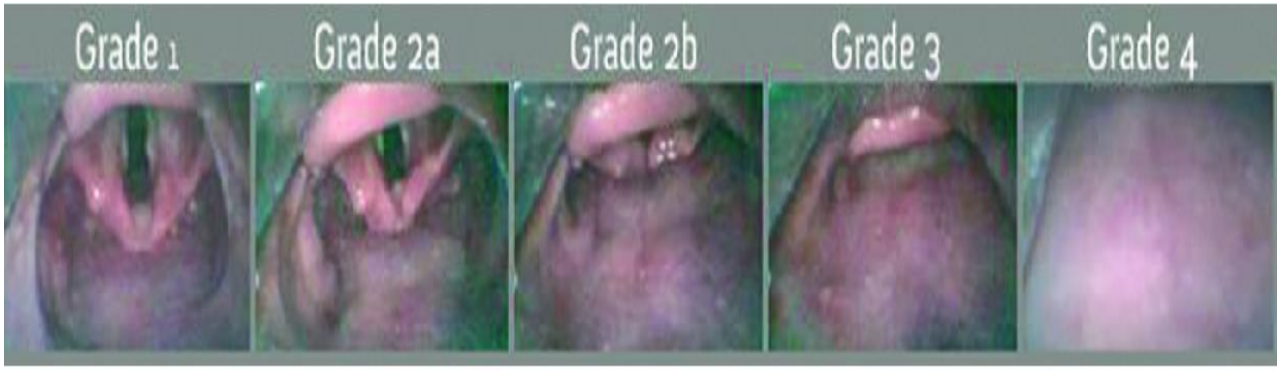
TABLE 3: Modified Cormack Lehane Grading

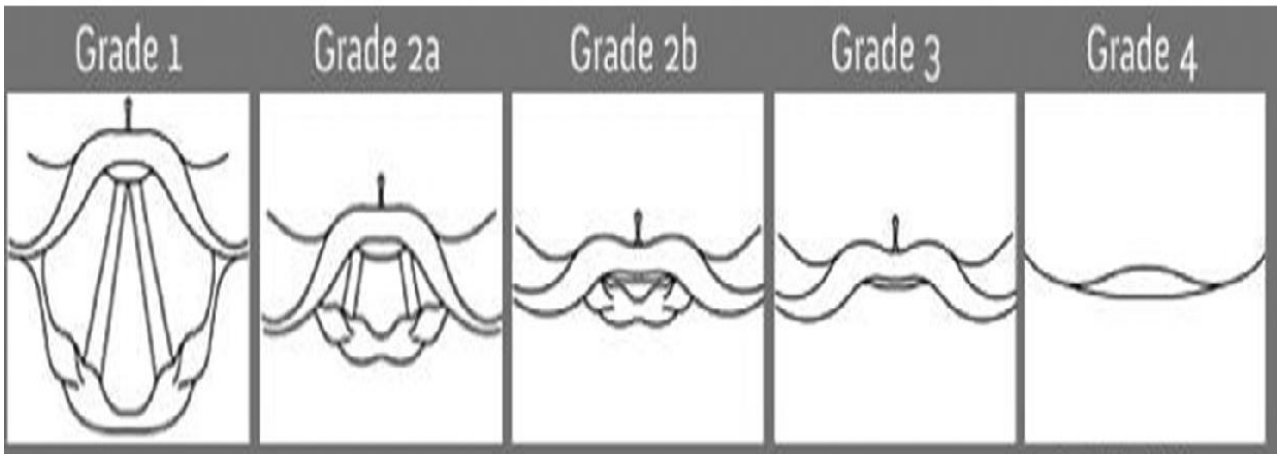
GRADE	VISIBILITY OF GLOTTIC STRUCTURES
I	Full view of glottis.
II a	Partial view of the vocal cords.
II b	Only the arytenoids and epiglottis seen.
III	Only the epiglottis is visible
IV	Neither epiglottis nor glottis is seen.

Grades II b, III and IV are considered as difficult visualization of larynx (DVL).[11]

Preoperative airway predictor tests are compared with Modified Cormack-Lehane grading as it is gold standard in order to quantify the best airway predictor to predict difficult airway.

FIGURE 9





MATERIALS AND METHODS

SOURCE OF DATA - Patients belonging to either gender, between 18 & 70 years of age, belonging to American Society of Anesthesiologists (ASA) physical status I & II who are scheduled to undergo elective surgery under general anaesthesia requiring oral endotracheal intubation at KLES Dr. Prabhakar Kore Charitable Hospital, Nehru Nagar, Belagavi -10 during the period from April 2021 to March 2022.

STUDY DESIGN - A One Year Hospital Based Prospective, Observational Study.

SAMPLE SIZE - Total sample size: 100

SAMPLE SIZE CALCULATION:

The formula used to find minimum sample size based on prevalence rate is

$$n = \frac{z_\alpha{}^2 P(1-P)}{d^2}$$

Where P is the prevalence percentage and d being the difference in the percentage of prevalence.

Z_α is linked to the level of significance. For 5% level of significance $Z_\alpha = 1.96$.

Ref: With P (percentage of deaths attributed to inability to manage difficult airways) = 40% and d = 25% of P = 10%,

The minimum sample size is 92.

To get better results the sample size has been be raised to 100.

PLACE - KLES Dr. Prabhakar Kore Charitable Hospital, Jawaharlal Nehru Medical College, KAHER, Belagavi-10.

SELECTION CRITERIA:

INCLUSION CRITERIA:

- Patients belonging to ASA physical status I and II.
- Patients of age group between 18 and 70 years.
- Patients undergoing elective surgeries under general anaesthesia requiring oral endotracheal intubation.
- Patients who provide consent.

EXCLUSION CRITERIA:

- Patients who are unable to give consent.
- Patients undergoing emergency surgeries.
- Patients with contraindication to general anaesthesia.
- Patients requiring rapid sequence induction.
- Patients with anatomical deformities in the front of neck.

METHODOLOGY

After approval from the Institutional ethics committee and obtaining informed consent from the patients participating in the study, this one year observational study was conducted at KLEs Dr. Prabhakar Kore Charitable Hospital, Jawaharlal Nehru Medical College, Belagavi.

After having met inclusion and exclusion criteria and having obtained written informed consent, a total of 100 patients undergoing elective surgery under general anaesthesia requiring oral endotracheal intubation were included in the study.

A thorough pre-anaesthetic evaluation was done on the day before surgery. During pre-anaesthetic evaluation, patients' age, sex, height, weight, ASA physical status and body mass index (BMI) were recorded. Fasting Blood Sugar (FBS), Complete blood count (CBC), serum

Creatinine were done for all patients. Chest X-ray and Electrocardiogram were done for patients above 40 years of age.

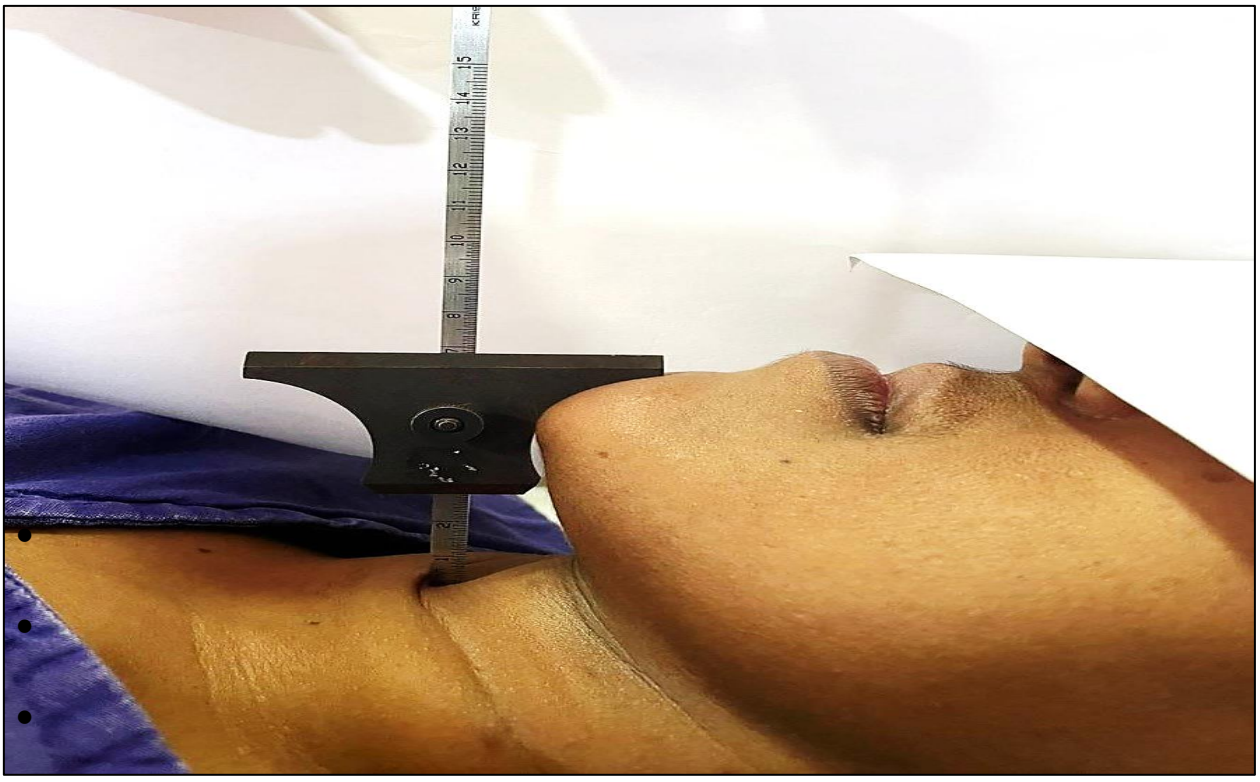
The following pre-operative airway predictive tests were done on the day before surgery:

- **THYROMENTAL HEIGHT (TMH):**

  It is the height between the anterior border of the thyroid cartilage and the anterior border of the mentum with head in neutral position keeping his/her mouth closed. The height was measured with the help of vernier depth gauge.

PHOTOGRAPH 1 – VERNIER DEPTH CALIPER

PHOTOGRAPH 2 – THYROMENTAL HEIGHT



- **THYROMENTAL DISTANCE (TMD):**

It is the distance from the bony point of the mentum to the thyroid notch, with head in full extension and mouth closed. It was measured with the help of a rigid ruler.

PHOTOGRAPH 3 – THYROMENTAL DISTANCE

- **RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD):**

It is measured as Patient's height (in cm) / Thyromental Distance (TMD).

- **MODIFIED MALLAMPATI TEST (MMT)**:

Mallampati grading was estimated by instructing the patient to sit and open his/her mouth to maximum and asked to protrude their tongue without phonation.

It is graded as follows:

TABLE 2: Modified Mallampati Test Classification

GRADE	OROPHARYNGEAL STRUCTURES VISIBLE
I	Soft palate, fauces, uvula, anterior and posterior tonsillar pillars.
II	Soft palate, fauces, uvula.
III	Soft palate, base of uvula.
IV	Only hard palate.

Grades III and IV were considered as risk factor for difficult airway.[12]

PHOTOGRAPH 4 – MODIFIED MALLAMPATI TEST

All the patients were kept on nil by mouth status for 8 hours before surgery. On the day of surgery, all standard monitoring devices were attached before induction of anaesthesia, including Non-invasive blood pressure, Electrocardiogram, Pulse oximeter and capnometer.

In the operating theatre, after recording baseline vitals, patients were pre-medicated with Inj. Glycopyrrolate 0.005 mg/kg, Inj. Midazolam 0.05 mg/kg and Inj. Fentanyl 2 mcg/kg, and then induced with Inj. Propofol 2 mg/kg following which muscle relaxation was achieved by Inj. Succinyl choline 2 mg/kg. After 45 seconds, direct laryngoscopy was done by the anaesthesiologist in sniffing position, who has not taken part in airway assessment, using Macintosh #3 or #4 blade. Sniffing position was achieved for intubation by elevation of patient's head using a pillow of 10 cm height.

The laryngeal view was then graded by Modified Cormack-Lehane scoring system. Endotracheal intubation was done using suitable endotracheal tube (7.5mm Internal diameter Endotracheal tube for women and 8.5mm Internal diameter Endotracheal tube for men) and then confirmed by five-point auscultation over the lung fields and capnography.

PHOTOGRAPH 5 – MODIFIED CORMACK-LEHANE GRADING

Modified Cormack-Lehane grading system is as follows:

TABLE 3: Modified Cormack Lehane Grading

GRADE	VISIBILITY OF GLOTTIC STRUCTURES
I	Full view of glottis.
II a	Partial view of the vocal cords.
II b	Arytenoids and epiglottis are seen.
III	Only the epiglottis is seen
IV	Neither glottis nor epiglottis is seen.

Grades II b, III and IV were considered as difficult visualization of larynx (DVL).[11]

Modified Cormack Lehane grading was taken as the gold standard to assess difficult airway intraoperatively. All the preoperative airway assessment tests were compared with Modified Cormack-Lehane scoring system to evaluate the predictive accuracy of the tests.

All the data gathered from the patients were taken for statistical analysis and validity indices like sensitivity, specificity, positive predictive value and negative predictive value were calculated.

- Sensitivity is the True Positive rate that tells us what percentage of the total sample is correctly predicted as difficult airway. The percentage of rightly predicted difficult intubation as a proportion of all intubations that were actually difficult. It is expressed as True positives / (True positives + False negatives).

- Specificity is the True negative rate that tells us what percentage of the total sample is correctly predicted as NOT a difficult airway. The percentage of rightly predicted easy intubations as a proportion of all intubations that were actually easy. It is expressed as True negatives / (True negatives + False positives).

- Positive Predictive Value (PPV) tells us the probability that the difficult airway predicted is actually present. The percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations. i.e. True positives / (True positives + False positives).

- Negative Predictive value (NPV) tells us the probability that the difficult airway is not present as predicted. The percentage of correctly predicted easy intubations as a proportion of allpredicted easy intubations. i.e. True negatives / (True negatives + False negatives).

RECEIVER OPERATOR CHARACTERISTIC CURVE (ROC):

The probability curve known as RECEIVER OPERATOR CURVE serves to fundamentally separate the "signal" from the "noise" by plotting the true positive rate against the false positive rate at various threshold values. As a summary of ROC curve, the “AREA UNDER THE CURVE” (AUC) measures a classifier's capacity to distinguish between classes. The model performance at differentiating among the positive and negative classes is improved by higher AUC.

AUC=1 allows the classifier to perfectly differentiate among all the positive and the negative class points correctly, while AUC = 0 allows the classifier to predict all negatives as positives and all positives as negatives

.

STATISTICAL ANALYSIS:

This is a prospective, observational study.

We calculated mean and standard deviation for continuous, quantitative variables.

Discrete variables represented by median and suitable graphs were analysed with Nonparametric tests.

Rates, ratios & percentages were used to express categorical data.

Validity indices were calculated for preoperative airway assessment and intubation findings.

We used Fisher's Exact test for outcome and clinical & demographic characteristics to study their association.

95% Confidence Interval (CI) was calculated with lower & higher ranges.

Collected data were tabulated in the Microsoft Excel Sheet and analysed on SPSS software version 21.

Receiver Operating Characteristic (ROC) curve was constructed for Thyromental height (TMHT), Thyromental distance (TMD) and Ratio of Height to Thyromental Distance (RHTMD) to determine the optimal cut-off value and prediction rate for difficult airway.

RESULTS

This study titled **"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"** was conducted.

100 patients were included in the study after meeting inclusion and exclusion criteria.

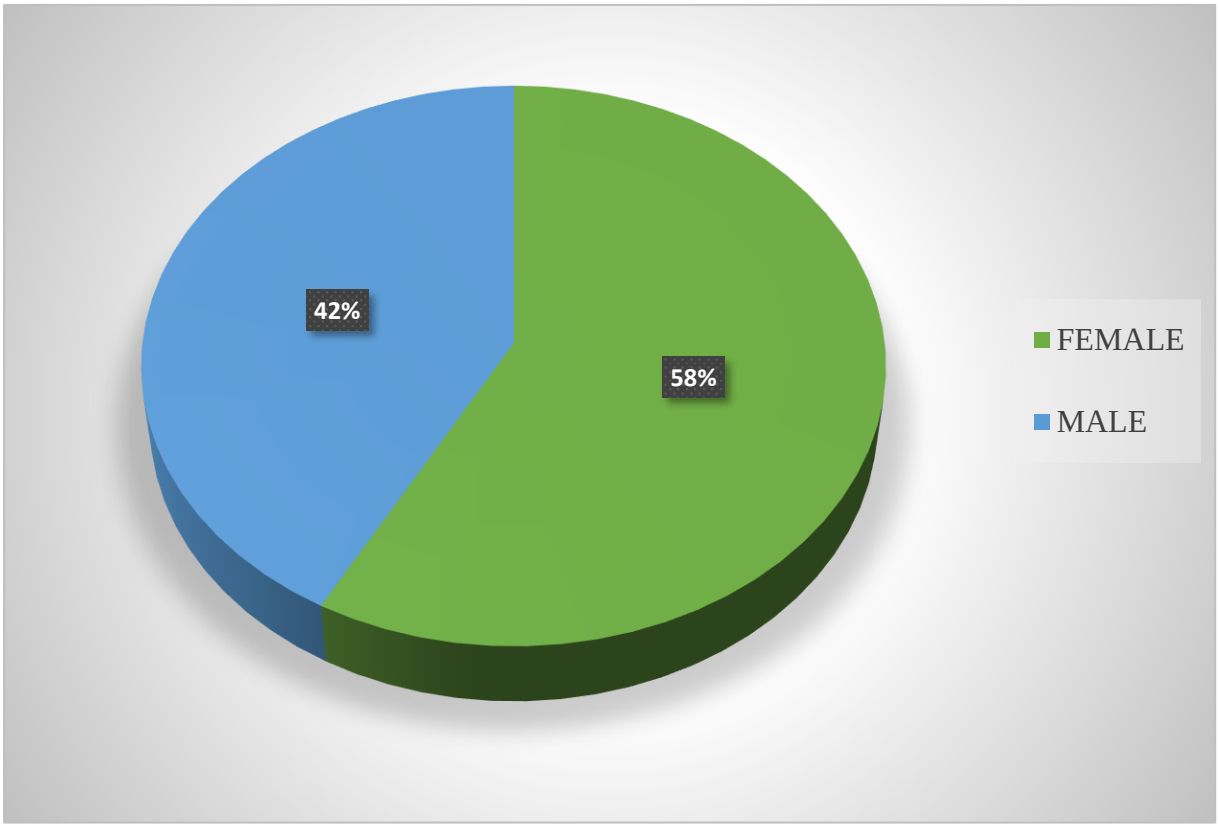
GENDER DISTRIBUTION:

TABLE 4: Gender Distribution of Volunteers Studied

GENDER	NUMBER
FEMALE	58
MALE	42
TOTAL	100

Out of 100 patients in this study, 42 were males and 58 were females. Male to Female ratio is 42:58 = 0.72.

GRAPH 1: Gender Distribution of volunteers studied



AGE DISTRIBUTION:

TABLE 5: Age Distribution of Volunteers Studied

AGE IN YEARS	NUMBER
18 - 24	12
25 - 34	16
35 - 44	18
45 - 54	29
55 - 64	19
65 - 70	6
TOTAL	100

GRAPH 2: Age Distribution of volunteers studied

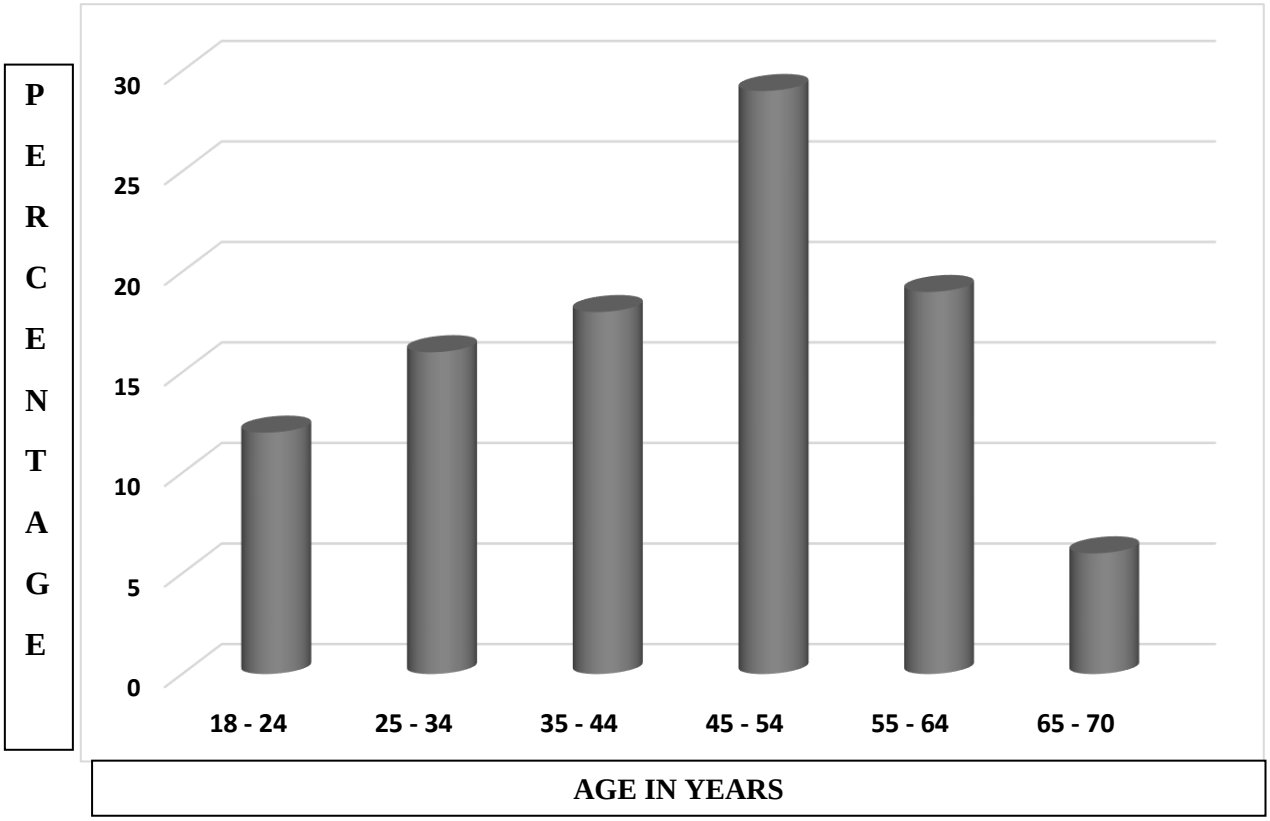


TABLE 6: Statistical analysis of Age Distribution of volunteers studied

	MEAN	S.D.	MIN	MAX
AGE (In Years)	43.36	13.99	18	70

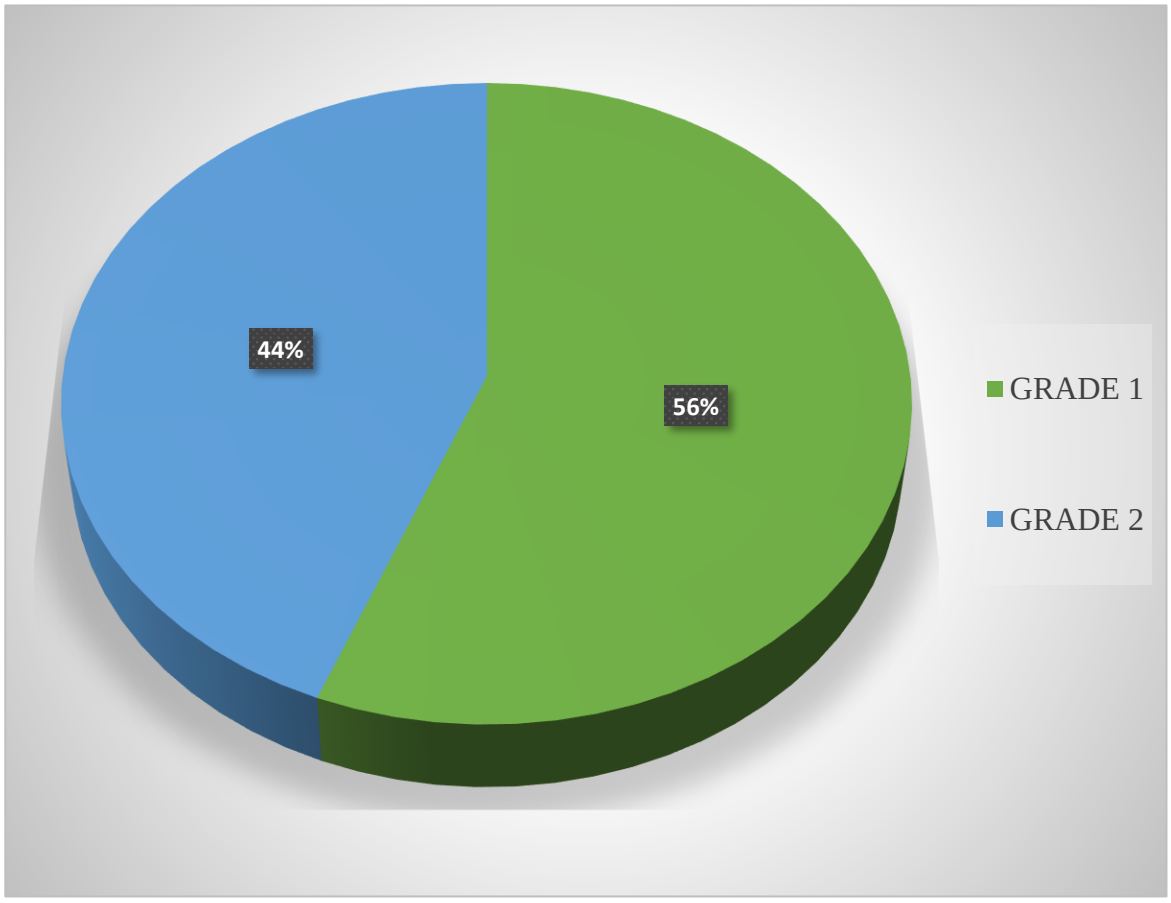
Mean age of the volunteers studied is found to be 43 years. Volunteers with the minimum age of 18 years and maximum age of 70 years were included in the study. Majority of the patients belonged to age group in the range of 45 – 54 years which is 29%.

American Society of Anaesthesiologist (ASA) Status:

TABLE 7: American Society of Anaesthesiologist Status Distribution of Volunteers Studied

ASA GRADE	NUMBER
1	56
2	44
TOTAL	100

GRAPH 3: ASA Distribution of volunteers Studied



ANTHROPOMETRIC DATA

TABLE 8: Anthropometric Data of volunteers studied

	MEAN	S.D.	MIN	MAX
HEIGHT (cm)	162.84	6.30	150	176
WEIGHT (Kg)	62.57	12.27	35	99
BMI (kg/m^2)	23.62	4.19	15.15	41.25

S.D. – Standard Deviation; MIN- Minimum; MAX- Maximum

Mean height of the volunteers studied is 162.84 cm. Minimum height recorded is 150 cm and maximum height is 176 cm.

Mean weight of the volunteers studied is 62.57 kg. Least weight recorded is 35 kg and maximum weight is 99 kg.

Mean Body Mass Index (BMI) calculated is 23.62 kg/m^2. Least BMI recorded is 15.15 kg/m^2 and maximum BMI is 41.25 kg/m^2.

PREOPERATIVE AIRWAY PREDICTIVE TESTS

TABLE 9: Statistical Analytical values distribution of Airway Predictor Tests

	MEAN	S.D.	MIN	MAX
THYROMENTAL HEIGHT (cm)	6.47	0.66	5	7.8
THYROMENTAL DISTANCE (cm)	8.67	1.45	6	11.5
RATIO OF HEIGHT TO THYROMENTAL DISTANCE	19.29	3.42	14	27.3
MODIFIED MALLAMPATI GRADE			1	4

S.D. – Standard Deviation; MIN- Minimum; MAX- Maximum

Mean value of Thyromental height, Thyromental distance & Ratio of Height to Thyromental Distance in this study are found to be 6.47cm, 8,67cm and 19.29 respectively.

Minimum value of Thyromental height, Thyromental distance and Ratio of Height to Thyromental Distance in this study are found to be 5cm, 6cm and 14 respectively.

Maximum value of Thyromental height, Thyromental distance and Ratio of Height to Thyromental Distance in this study are found to be 7.8cm, 11.5cm and 27.3 respectively.

Minimum grade of Modified Mallampati Test is Grade 1 and Maximum grade is grade 4.

INTRAOPERATIVE GLOTTIC VISUALISATION DURING LARYNGOSCOPY BY CORMACK-LEHANE GRADING

TABLE 10: Modified Cormack-Lehane Grading Distribution of volunteers studied

MODIFIED CORMACK-LEHANE GRADE	NUMBER OF PATIENTS
I	18
II a	53
II b	7
III	22
	TOTAL = 100

Modified Cormack-Lehane Grades I and II a is considered easy laryngoscopy and intubation. Grades IIb, III and IV are considered difficult intubation. In this study, majority of the volunteers were found to be Modified C-L Grade II a which is 53%, followed by Grade III which is 22% and grade I which is 18%. 7% of the volunteers had Cormack-Lehane Grade IIb. None of the volunteers was found to have C-L grading of IV. In this study 29% of the patients were considered difficult intubation by C-L grading. Thus the incidence of difficult airway in our study is 29%. Other preoperative airway predictive tests were compared with Modified Cormack Lehane grading which is considered as gold standard to validate the best airway predictor.

DIFFICULT INTUBATION PREDICTED BY THYROMENTAL HEIGHT (TMHT)

Taking into account the previous studies done on Thyromental Height, optimal cut off value is taken as 5.8 cm. Any value ≤ 5.8 cm is predicted to be difficult airway.[4]

In this study 16% of patients had Thyromental height of ≤ 5.8 cm.

TABLE 11: Difficult Airway prediction by Thyromental Height

THYROMENTAL HEIGHT	NUMBER OF PATIENTS
≤ 5.8 cm	**16**
>5.8 cm	**84**
TOTAL	**100**

TABLE 12: Comparison of difficult intubation predicted by Thyromental Height with Modified Cormack-Lehane Grading

	MODIFIED CORMACK LEHANE GRADE		
USING THYROMENTAL HEIGHT	**EASY**	**DIFFICULT**	**TOTAL**
EASY	64	20	84
DIFFICULT	7	9	16
TOTAL	71	29	100

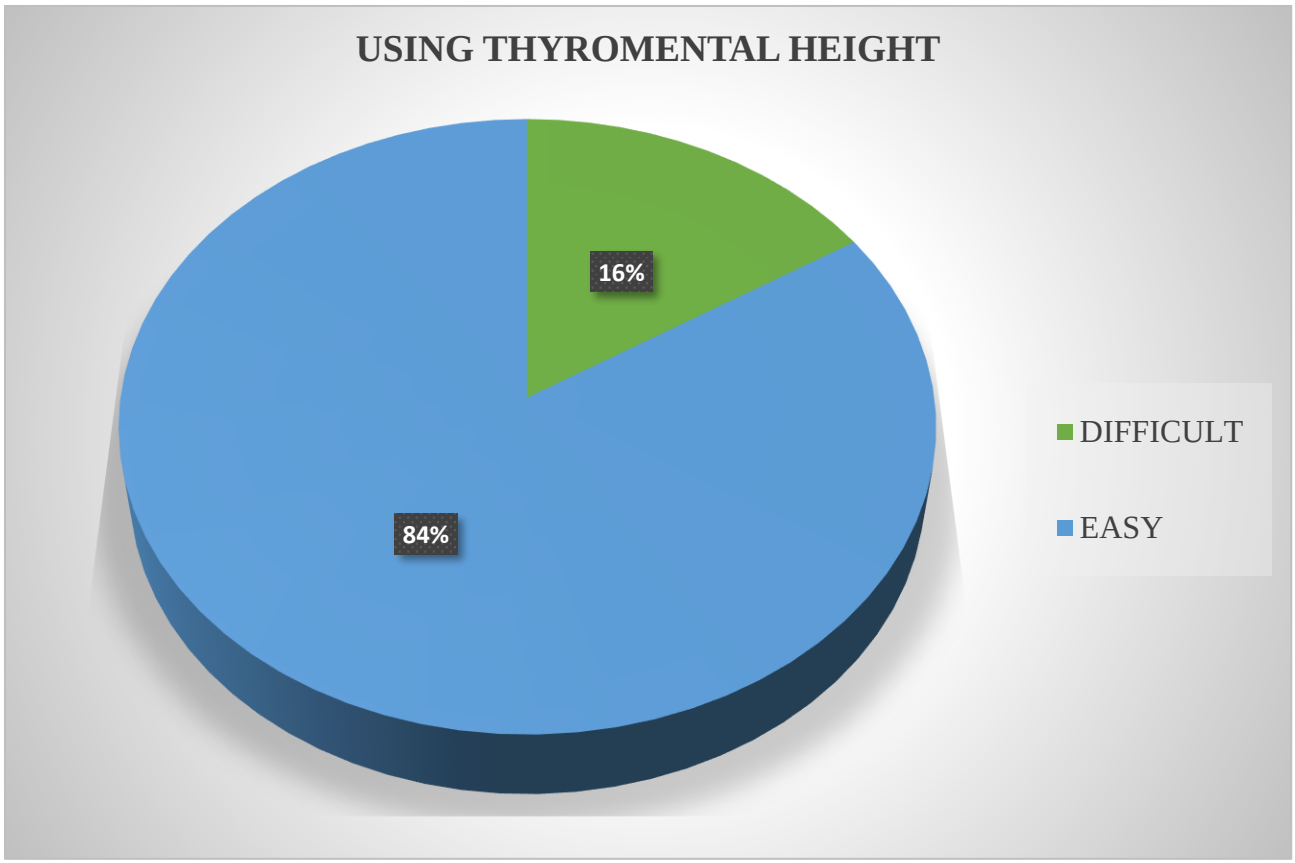
True positive – 64

True negative – 9

False positive – 20

False negative - 7

GRAPH 4 : Difficult Airway prediction by Thyromental Height



- **Sensitivity = 92.96%**

  95% CI: Lower range - 87.01% & Higher range - 98.91%

- **Specificity = 31.03%**

  95% CI: Lower range - 14.20% & Higher range - 47.87%

- **Positive Predictive Value = 76.19%**

  95% CI: Lower range - 67.08% & Higher range - 85.30%

- **Negative Predictive Value = 56.25%**

  95% CI: Lower range - 31.94% & Higher range - 80.56%

- **Diagnostic Accuracy = 73 %**

DIFFICULT INTUBATION PREDICTED BY THYROMENTAL DISTANCE (TMD)

Taking into account the previous studies done on Thyromental Distance, optimal cut off value is taken as 6.7 cm. Any value ≤ 6.7 cm is predicted to be difficult airway.[13]

In this study 12% of patients had Thyromental Distance of ≤ 6.7 cm.

TABLE 13: Difficult Airway prediction by Thyromental Distance

THYROMENTAL DISTANCE	NUMBER OF PATIENTS
≤ 6.7 cm	**12**
>6.7 cm	**88**
TOTAL	**100**

TABLE 14: Comparison of difficult intubation predicted by Thyromental Distance with Modified Cormack-Lehane Grading

	MODIFIED CORMACK LEHANE GRADE		
USING THYROMENTAL DISTANCE	**EASY**	**DIFFICULT**	**TOTAL**
EASY	66	22	88
DIFFICULT	5	7	12
TOTAL	71	29	100

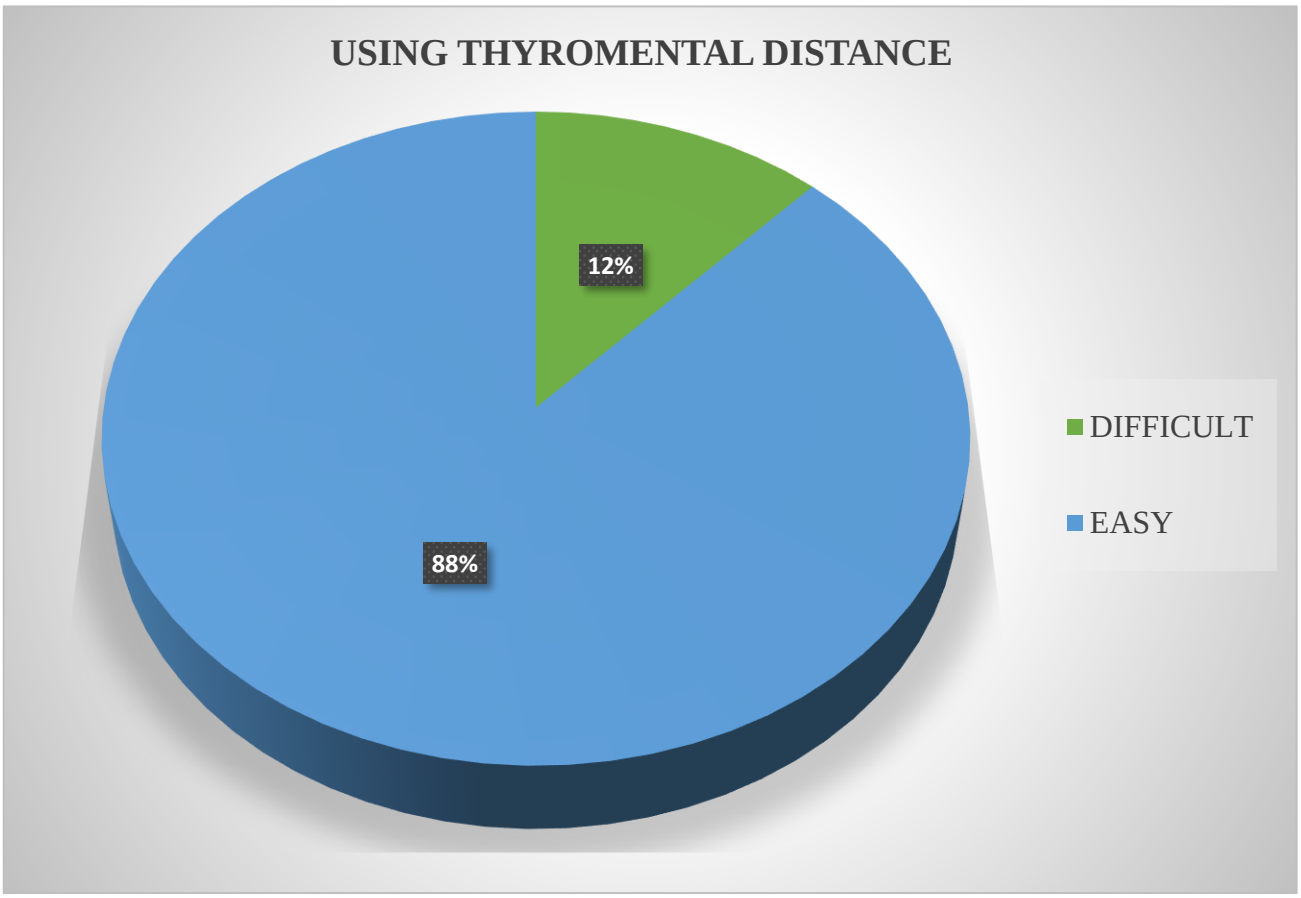
True positive – 66

True negative – 7

False positive – 22

False negative - 5

GRAPH 5: Difficult Airway prediction by Thyromental Distance



- **Sensitivity = 90.14%**

  95% CI: Lower range - 83.21% & Higher range - 97.08%

- **Specificity = 24.14%**

  95% CI: Lower range - 8.56% & Higher range - 39.71%

- **Positive Predictive Value = 75.00%**

  95% CI: Lower range - 65.95% & Higher range - 84.05%

- **Negative Predictive Value = 58.33%**

  95% CI: Lower range - 30.44% & Higher range - 86.23%

- **Diagnostic Accuracy = 70 %**

DIFFICULT INTUBATION PREDICTED BY RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD):

Taking into account the previous studies done on Ratio of Height to Thyromental Distance, optimal cut off value is taken as 20.5 as the study is done on Caucasian population. Any value ≥ 20.5 is predicted to be difficult airway.[6]

In this study 29% of patients had Ratio of Height to Thyromental Distance of ≥ 20.5.

TABLE 15: Difficult Airway prediction by Ratio of Height to Thyromental Distance

RATIO OF HEIGHT TO THYROMENTAL DISTANCE	NUMBER OF PATIENTS
≥ 20.5	**29**
< 20.5	**71**
TOTAL	**100**

TABLE 16: Comparison of difficult intubation predicted by Ratio of Height to Thyromental Distance with Modified Cormack-Lehane Grading

	MODIFIED CORMACK LEHANE GRADE		
USING RATIO OF HEIGHT TO THYROMENTAL DISTANCE	**EASY**	**DIFFICULT**	**TOTAL**
EASY	55	16	71
DIFFICULT	16	13	29
TOTAL	71	29	100

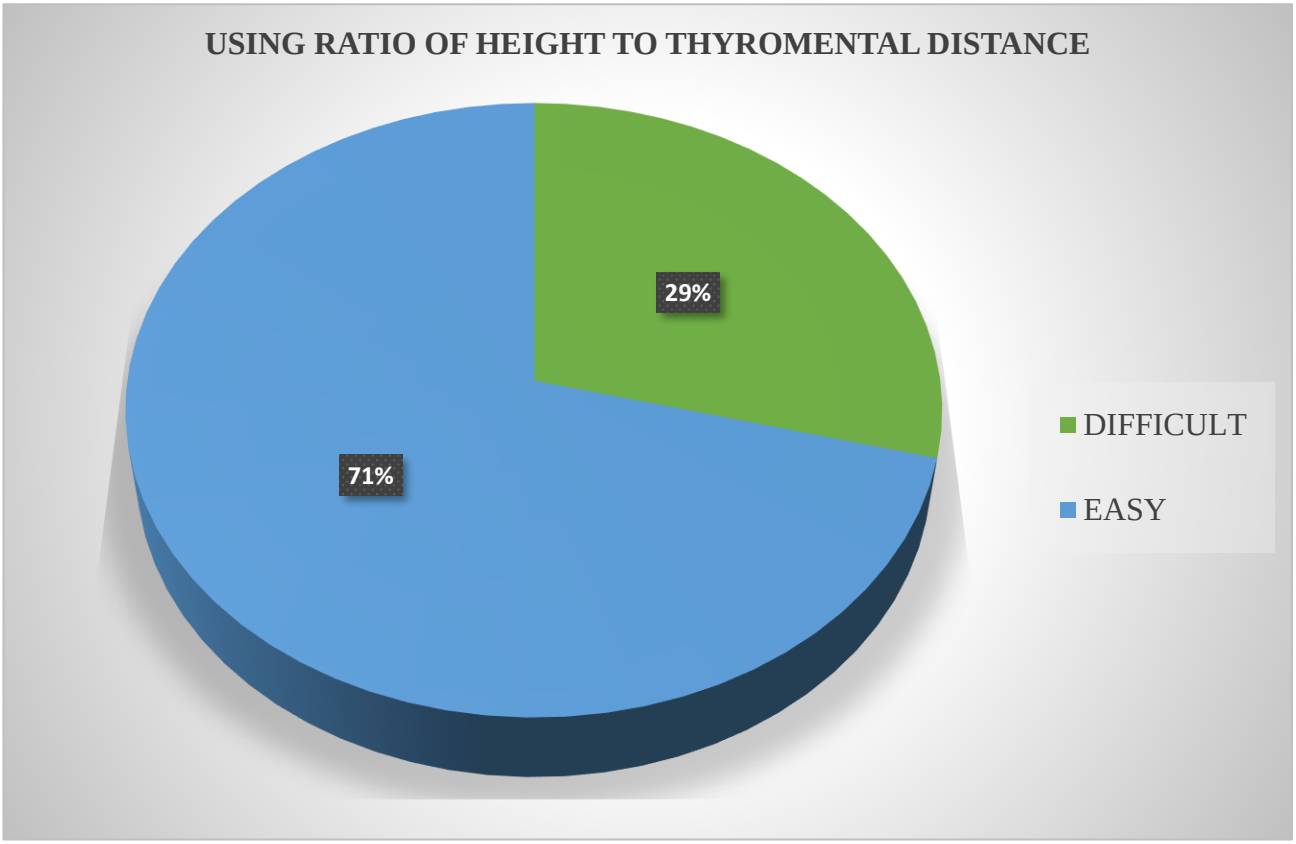
True positive – 55

True negative – 13

False positive – 16

False negative - 16

GRAPH 6: Difficult Airway prediction by Ratio of Height to Thyromental Distance



- **Sensitivity = 77.46%**

  95% CI: Lower range - 67.75% & Higher range - 87.18%

- **Specificity = 44.83%**

  95% CI: Lower range - 26.73% & Higher range - 62.93%

- **Positive Predictive Value = 77.46%**

  95% CI: Lower range - 67.75% & Higher range - 87.18%

- **Negative Predictive Value = 44.83%**

  95% CI: Lower range - 26.73% & Higher range - 62.93%

- **Diagnostic Accuracy = 68 %**

DIFFICULT INTUBATION PREDICTED BY MODIFIED MALLAMPATI TEST (MMT)

TABLE 17: Modified Mallampati Grading Distribution of volunteers studied

MODIFIED MALLAMPATI GRADE	NUMBER OF PATIENTS
I	12
II	58
III	29
IV	1
	TOTAL = 100

Grades III and IV are considered as difficult airway.[12] In this study 30% of patients were predicted to have Difficult airway by Modified Mallampati Test.

TABLE 18: Comparison of difficult intubation predicted by Modified Mallampati Test with Modified Cormack-Lehane Grading

	MODIFIED CORMACK LEHANE GRADE		
USING MODIFIED MALLAMPATI GRADE	**EASY**	**DIFFICULT**	**TOTAL**
EASY	60	10	70
DIFFICULT	11	19	30
TOTAL	71	29	100

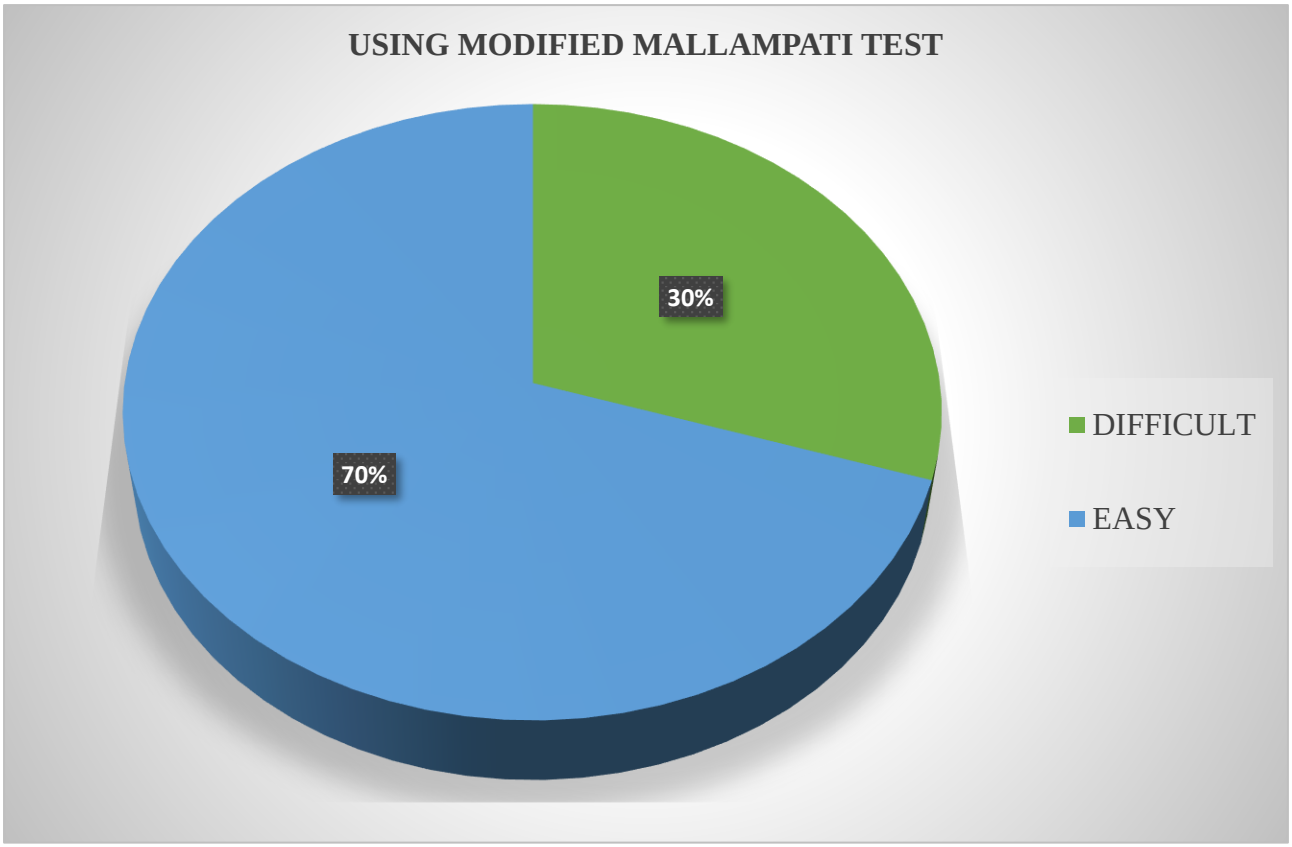
True positive – 60

True negative – 19

False positive – 10

False negative - 11

GRAPH 7: Difficult Intubation Predicted by Modified Mallampati Test



- **Sensitivity = 84.51%**

95% CI: Lower range - 76.09% & Higher range - 92.92%

- **Specificity = 65.52%**

95% CI: Lower range - 48.22% & Higher range - 82.82%

- **Positive Predictive Value = 85.71%**

95% CI: Lower range - 77.52% & Higher range - 93.91%

- **Negative Predictive Value = 63.33%**

95% CI: Lower range - 46.09% & Higher range - 80.58%

- **Diagnostic Accuracy = 72 %**

VALIDITY INDICES OF PREOPERAITVE AIRWAY PREDICTIVE TESTS

TABLE 19: Comparison of Validity Indices values of Airway Predictors

TEST	SENSITIVITY (%)	SPECIFICITY (%)	PPV (%)	NPV (%)
Thyromental Height (TMHT)	92.96	31.03	76.19	56.25
Thyromental Distance (TMD)	90.14	24.14	75.00	58.33
Ratio of Height to Thyromental Distance (RHTMD)	77.46	44.83	77.46	44.83
Modified Mallampati Test (MMT)	84.51	65.52	85.71	63.33

PPV–Positive Predictive Value ; NPV – Negative Predictive Value

TABLE 20: Diagnostic Accuracy of Airway Predictive Tests

AIRWAY PREDICTIVE TESTS	ACCURACY
Thyromental Height (TMHT)	73%
Thyromental Distance (TMD)	70%
Ratio of Height to Thyromental Distance (RHTMD)	68%
Modified Mallampati Test (MMT)	72%

DISCUSSION

Preoperative airway assessment is a routine anaesthetic practice which is essential to identify difficult airway and so appropriate planning and arrangements can be done to secure airway in patients with anticipated difficult airway. Difficulty faced during securing airway can be catastrophic besides resulting in significant morbidity and mortality. About 30%-40% deaths related to anaesthesia is attributable to failure in managing difficult airway. Unanticipated difficult airway and associated morbidity can be reduced to a greater extent by assessing patient's airway in the preoperative period by various bedside airway assessment tests which has been proposed by various studies in the past. The basic initial step to be carried out in planning airway management is airway assessment. Thus it is very crucial for anaesthesiologists to assess the likelihood of difficult intubation accurately the day before surgery.

In this study we compared four airway predictive tests namely Thyromental Height Test (THMT), Thyromental Distance (TMD), Modified Mallampati Test (MMT) and Ratio of Height to Thyromental Distance (RHTMD) to predict difficult airway in order to validate the best airway assessment test. All the four airway predictive tests were compared with Modified Cormack-Lehane (C-L) Grading which is considered gold standard.

Modified Cormack-Lehane grading has 5 grades - Grade I, II a, II b, III and IV.
Modified C-L Grades I and II A are considered easy laryngoscopy whereas Grades II b, III and IV are considered difficult laryngoscopy and intubation.

In this study, majority of the patients were found to have C-L Grade II a which is 53%, followed by Grade III which is 22% and Grade I which is 18%. 7% of them had C-L grade IIb. Nome of them had C-L grade IV.

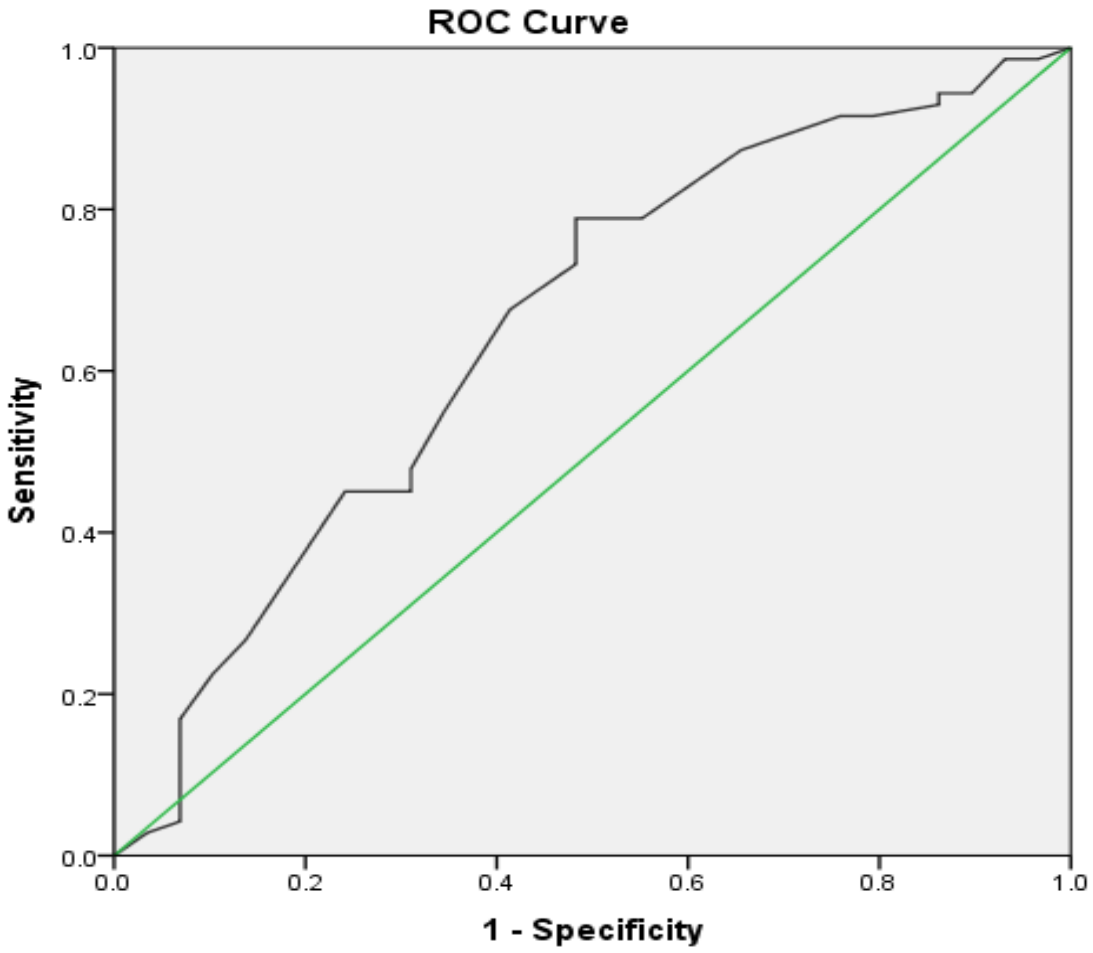
Comparison is done statistically by taking into account the validity indices such as sensitivity, specificity, positive predictive value and negative predictive value. Among the four predictive tests compared in this study, Thyromental Height is a comparatively new airway predictor and not much studies have been done before to assess the predictive accuracy of this screening test.

Incidence of difficult airway & intubation as reported by several studies conducted before varies from 1.3% to 13% in patients undergoing surgery under general anaesthesia. Incidence of Cannot Intubate and Cannot Ventilate (CICV) is 0.0001% to 0.02%. The wide variation in the incidence of difficult airway could be due to various factors such as ethnic differences among population under study, recommended position for intubation (sniffing position), adopting external laryngeal maneuver and various criteria followed to define difficult airway and intubation. In this study the incidence of difficult intubation was 29%. This is quite high owing to lesser sample size. Incidence of difficult intubation is calculated based on the Modified Cormack-Lehane Scoring system which is a gold standard test.

THYROMENTAL HEIGHT TEST (TMHT):

A relatively new airway assessment test known as Thyromental height test (TMHT) was introduced by Etezadi and others in 2013. Based on their study shorter the Thyromental height the more difficult will be laryngoscopy and intubation. This is due to the fact that in patients with anterior larynx, Backward, Upward and Rightward Pressure (BURP) is employed, which raises thyromental height to get a better glottic view during laryngoscopy. In our study the cut-off value for Thyromental Height is calculated using Area Under Curve (AUC) of the Receiver Operator Characteristic (ROC) curve which gives the optimal cut off value as 5.8cm which is higher than the cut-off value proposed by Etezadi and others which was 5cm. Mean Thyromental Height in our study is 6.47 cm. In this study, validity indices for thyromental height are calculated. Sensitivity, Specificity, Positive predictive value and Negative predictive value for TMHT were found to be 92.96%, 31.03%, 76.19%, 56.25% respectively. In the study conducted by Panjiar and others these values were 78.18%, 93.94%, 58.90% and 97.48%. In the original study conducted by Etezadi and others, these values were 82.6%, 99.31%, 90.47% and 98.63%. In this study, diagnostic accuracy of Thyromental height is 73% whereas in the study conducted by Panjiar et al it was 92.36%. Statistical analytical values are different in our study compared to the above mentioned studies. Conclusion is similar to that of previous studies which showed that Thyromental Height is the most sensitive screening tool compared to other three airway predictor tests studied.

GRAPH 8: ROC curve for Thyromental Height Test (TMHT)



AREA UNDER THE CURVE = 0.6563

RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD):

Patients who participated in this study belong to a same subset of population with no difference in ethnicity or anthropometry. Wide variation in anthropometry would be a confounding factor in quantifying one of the airway predictors – Ratio of Height to Thyromental Distance (RHTMD) which takes into account patient's height. Schmitt and others introduced this test in 2002 after testing the hypothesis that Ratio of Height to Thyromental Distance would improve the accuracy of predicting difficult airway compared with Thyromental Distance (TMD) alone. They found a ratio of 25 for RHTMD as optimal cut-off to predict difficult airway (i.e.) if the value is more than 25 then it is considered as difficult airway.

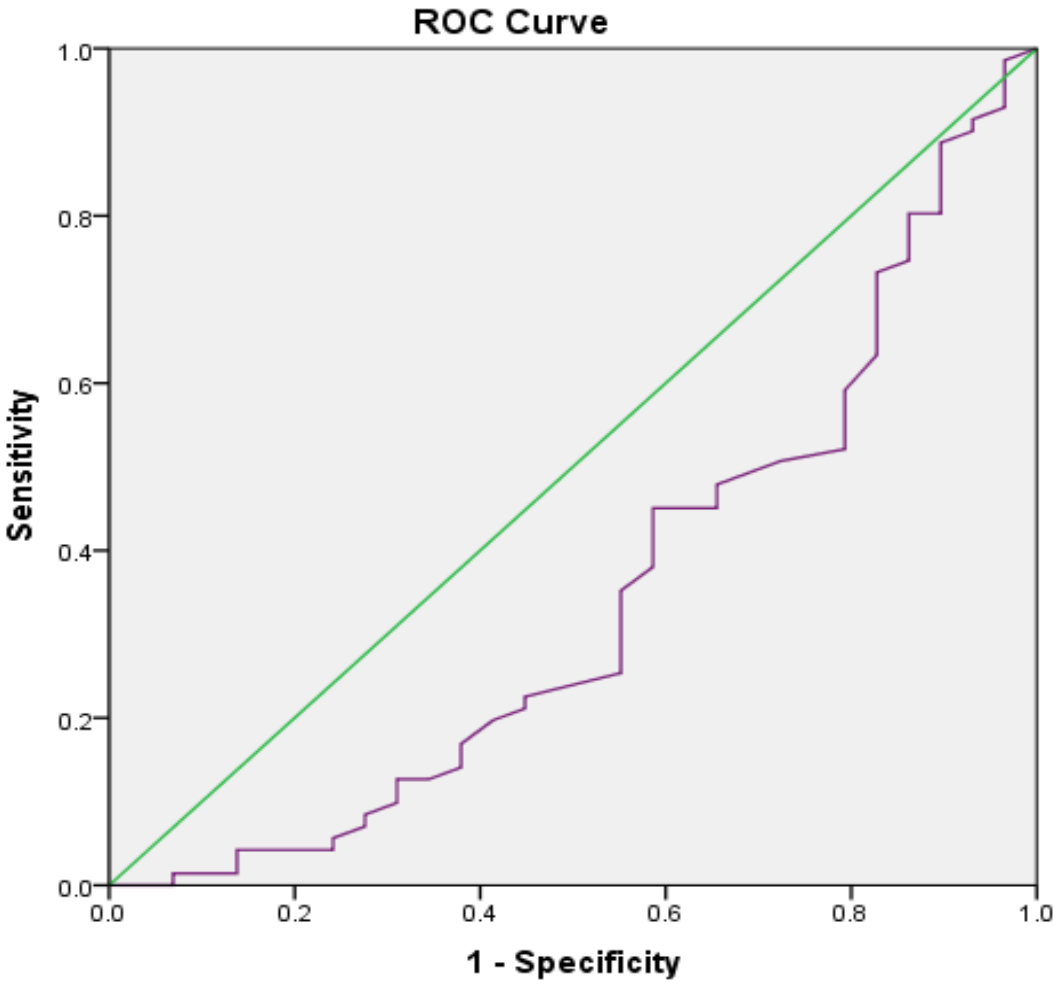
Another study by Kaniyil and others estimated the optimal cut-off value to be 22.1.[3] In a study done by Panjiar and others, this cutoff was calculated to be 19.5.[18] In this study, AUC of ROC curve was adopted to find the optimal cut-off for RHTMD and is found to be 20.5 which is close to the cut off calculated by Panjiar et al.

Safavi et al did a study on RHTMD and concluded that cut-off point for RHTMD to predict difficult airway is race dependent and recommend estimating cutoff point for each population separately.

The sensitivity of RHTMD in this study is 77.46% which is comparable with other studies done before. When compared to other airway predictive tests, RHTMD has least sensitivity but better specificity (44.83%) than TMD (24.14%) and TMHT (31.03%). Positive predictive value and Negative predictive value of RHTMD are 77.46% and 44.83% respectively which is comparable with other studies. However, compared to other airway predictors RHTMD has least PPV and NPV. Mean RHTMD in our study is found to be 19.29. Diagnostic accuracy of RHTMD in this study is found to be 68% which is the least among the other airway predictors

studied. Since there is no wide variation in the height of patients in our study (Average height is 162.8 cm), height as a confounding factor is eliminated in calculating the cut off of RHTMD.

GRAPH 9: ROC curve for Ratio of Height to Thyromental Distance



AREA UNDER THE CURVE = 0.3423

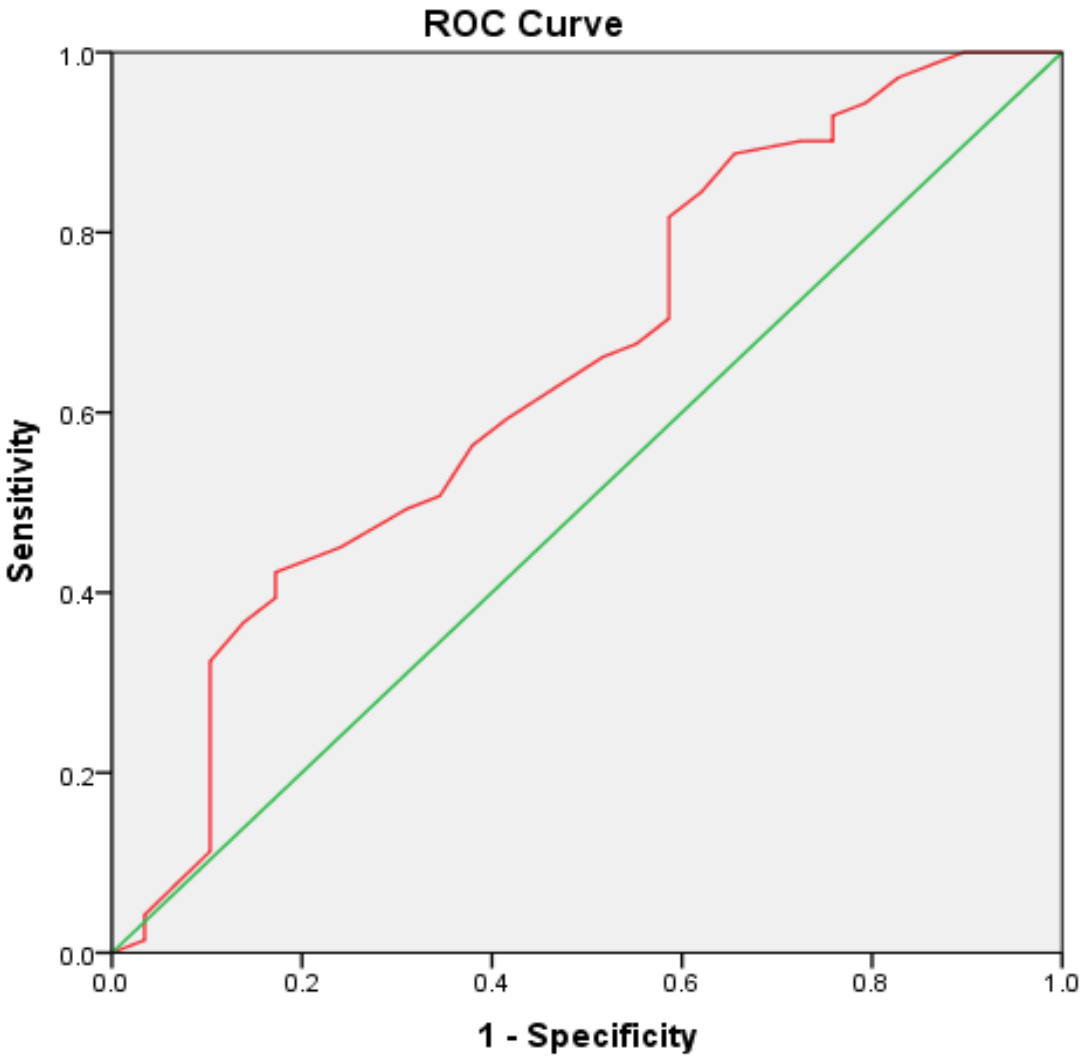
THYROMENTAL DISTANCE (TMD):

Thyromental Distance (TMD) as an airway predictive test was introduced in 1983 by Patil SV and others. Thyromental distance for this reason is also known as Patil's test. The original study done by Patil SV et al proposed three classes depending on values of Thyromental Distance. Class I if TMD is more than 6.5 cm which suggest easy intubation, Class II if TMD is between 6cm and 6.5cm and class III if distance is less than 6cm. TMD less than or equal to 6.5 cm was considered anticipated difficult airway according to their study.

In a study done by Schmitt et al in 2002, the cut off value of TMD was found to be 7 cm. Kaniyil and others did a study in 2018 comparing TMD and RHTMD and concluded that the optimal cut off of TMD according to their population under study was 6.55 cm and the mean value of TMD was 7.5 cm. TMD is found to have a wide range of cut-off value (5.5cm to 7cm) in literature.

In this study, the mean value of Thyromental distance is 8.67 cm which is higher than most studies done before. The optimal cut off value as calculated by AUC of the ROC is 6.8 cm which is lower than the study done by Schmitt et al but higher than most of the other studies done before. This may be due to lesser sample size of our study. Validity indices of TMD in this study are found to be sensitivity of 90.14%, specificity of 24.14%, Positive predictive value of 75.00% and Negative predictive value of 58.33%. Diagnostic accuracy of TMD in this study is found to be 70% which is lower than the earlier studies. Validity indices of TMD in this study are not comparable with the other known studies which showed high inter-observer variability of TMD. In previous studies, specificity of TMD was higher than sensitivity whereas in this study the result is reversed with sensitivity being higher than specificity and PPV being higher than NPV. However, sensitivity, PPV and NPV of TMD are comparable to Thyromental Height in this study.

GRAPH 10: ROC curve for Thyromental Distance (TMD)



AREA UNDER THE CURVE = 0.6493

MODIFIED MALLAMPATI TEST (MMT):

In this study, out of 100 patients, 30 of them were predicted to have difficult airway by Modified Mallampati Test. Majority of the patients were found to have Modified Mallampati Grade II which is 58%, followed by Grade III which is 29% and Grade I which is 12%. Only one of them had MMT grading of IV.

Mallampati and others introduced an airway predictive test in 1985 called Mallampati test to predict difficult airway. This was modified in 1987 by Dr. Samsoon and Dr. Young and has been in use since then as Modified Mallampati Test (MMT). It is considered as the commonly used standard bedside airway assessment test to predict difficult airway. The major limitation of this test is that it has high inter-observer variability and high incidence of false positives. Meta analysis which was done by Lundstrom and others concluded that Modified Mallampati Test (MMT) as a stand-alone test was a poor screening test to predict difficult airway.

In this study, Validity indices of MMT were calculated. It has sensitivity of 84.51%, specificity of 65.52%, Positive predictive value of 85.71% and Negative predictive value of 63.33%. Among the four predictive tests, MMT has the highest Specificity, PPV and NPV. Specificity and NPV of MMT in this study are also comparable to the reported values in previous studies. Diagnostic accuracy of MMT in this study is found to be 72% which is almost similar to that of Thyromental height (73%). However this study showed that MMT has least sensitivity compared to the other airway predictive tests. This test has the advantage that it can be applied to a vast majority of population irrespective of ethnic diversities and anthropometrical variations.

LIMITATIONS:

The limitations of this study are restricted demographic profile and lesser sample size. The sample size of our study was 100 patients whereas previous studies had a larger sample size, contributing to more significant outcomes. The results of this study may not be applicable to other racial groups owing to anthropometric variations in different population groups. This also makes it impossible to get an optimal cut-off value for the airway predictive tests used to predict difficult airway, which can be applied to other population groups.

FUTURE SCOPE:

We need further studies in the future with a larger sample size. Future studies can also focus on comparing Thyromental Height with various other airway predictive tests such as Sternomental distance, Hyomental distance, Upper Lip Bite Test (ULBT), Neck circumference and Ratio of Neck circumference to Thyromental Height (Nc/TMH) to evaluate its diagnostic accuracy in predicting difficult airway.

CONCLUSION:

The incidence of difficult airway in our study was 29%. We conclude our study stating that Thyromental Height is a good bedside airway assessment test for prediction of difficult airway. Predictive accuracy of Thyromental height is higher than the other tests suggesting that it is a better predictor of difficult airway. This study showed that sensitivity of Thyromental height is comparatively higher than the other airway predictive tests. Modified Mallampati test has highest specificity, PPV and NPV compared to other predictive tests however its sensitivity is lower than Thyromental height and Thyromental distance. We consider Thyromental height as a fairly reliable predictor of difficult airway and could be used in combination with other airway assessment tests to predict difficult airway. However it cannot be used as a standalone test for prediction of difficult intubation.

SUMMARY:

Present study entitled **"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"** was conducted at KLE's Dr. Prabhakar Kore Charitable Hospital, Nehru Nagar, Belagavi- 590010.

After obtaining ethical clearance from Institutional Human Ethics Committee and having met inclusion and exclusion criteria, 100 patients of ASA I & II between age group 18-70 years were included in the study after obtaining their written informed consent.

The aim of this study is to validate the best predictor of difficult airway by comparing Thyromental Height which is relatively a new airway predictor with other established predictors such as Thyromental distance, Modified Mallampati test and Ratio of Height to Thyromental Distance. All these airway predictors were compared with Modified Cormack-Lehane grading which is considered gold standard. Validity indices such as sensitivity, specificity, Positive predictive value and Negative predictive value were calculated for all four airway predictive tests. Diagnostic accuracy and optimal cut-off for each airway assessment test was calculated.

The study showed that Thyromental height had a high sensitivity among all the tests studied and has better diagnostic accuracy in predicting difficult airway. Modified Mallampati test which is extensively used in various population groups worldwide, had a high specificity, high positive and negative predictive value in our study.

Further studies can be done in future involving different ethnicity and various population groups with larger sample size comparing multiple airway assessment tests in order to validate the best test to predict difficult airway. Multicentric trials can be done throughout the world to standardize optimal cut off for Thyromental height. To summarize, none of the airway predictive tests which has been studied till date can be used as a stand-alone test which can predict difficult airway accurately. However multiple airway screening assessment tests can be used in combination which will help to identify patients at risk for difficult airway.

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ANNEXURE I

CONSENT FORM

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr./Mrs./Miss _____ we are requesting you to enroll yourself in study titled **"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"** conducted by **REG NO. BA0120003**, Post Graduate in M.D. Anaesthesiology under the guidance of **Dr. _____** Professor, Department of Anaesthesiology, J.N. Medical College, Belagavi under KLE University, Belagavi.

Respected Sir/Madam, we request you to participate in our study as you are eligible for the proposed study. During the study you will be asked some questions regarding the present complaints that you are having.

Your participation in this research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N. Medical College. If you decide to participate you are free to withdraw at any time.

Purpose of the study:

The purpose of research is to evaluate the diagnostic accuracy of Thyromental Height Test (TMHT) in predicting the difficult airway and to compare it with previously established airway predictors such as Thyromental distance (TMD), Modified Mallampati Test (MMT) and Ratio of Height to Thyromental distance (RHTMD) to assess the best predictor of difficult airway.

Procedure Involved:

If you agree to enroll in my study, I will ask you the present and past medical history and family history. Then you will be clinically examined in detail. Bedside clinical tests will be performed by me without any discomfort on the day before surgery. On the day of surgery, endotracheal intubation will be done by a senior anaesthesiologist and Cormack-Lehane grading will be done during laryngoscopy.

Voluntary Participation/ Withdrawal:

Taking part in the study is voluntary. You may choose not to enroll in this study. Your decision will not change present or future health care services offered to you at KLES Dr. Prabhakar Kore Charitable Hospital.

Alternatives:

Even if you decline your participation in the study, you will get the routine line of management.

Privacy and Confidentiality:

The only people to know that you are a research subject is you and the members of the research team. No information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study will be identified with your identity remaining confidential.

Financial Incentives for Participation: No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation: In the event of injury related to the study, treatment will be made available through K.L.E.S Dr. Prabhakar Kore Charitable Hospital, Belagavi. There is no compensation or payment for such medical treatment by law. If you get injured you may contact me at Department of Anaesthesiology, K.L.E.S Dr. Prabhakar Kore Charitable Hospital.

Questions: In case you have any questions related to the study, in future or in case of study related injury or illness, you can contact me at Department of Anaesthesiology, K.L.E.S Dr. Prabhakar Kore Charitable Hospital, Belagavi or my guide Dr. _____ Professor, Dept. Of Anaesthesiology, K.L.E.S Dr. Prabhakar Kore Charitable Hospital, Belagavi.

If you have any queries about your rights as a study subject, you may call Dr. Harsha Hegde **M.D**, Chairperson, J.N. Medical College, Institutional Ethical Committee & Scientist Department, ICMR, National Institute of Traditional Medicine, Belagavi – 10. Mobile number: 9480422500.

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"

I, _____ voluntarily agree for the participation as a subject of study. By signing this consent form, I am not giving up any of my legal rights, I may withdraw myself from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name: _____

Signature or the Left Thumb Print of Subject: _____

Date:

Investigator's Name: _____ Signature: _____

Date:

Place:

ANNEXURE II

PROFORMA

"COMPARISON OF THYROMENTAL HEIGHT WITH THYROMENTAL DISTANCE, MODIFIED MALLAMPATI TEST AND RATIO OF HEIGHT TO THYROMENTAL DISTANCE IN PREDICTING DIFFICULT AIRWAY: A ONE YEAR HOSPITAL BASED PROSPECTIVE OBSERVATIONAL STUDY"

Patient's Name	:	I.P No.	:
Age	:	Date of Examination	:
Gender	:	Anaesthesiologist	:
Address	:		

Pre-anesthetic evaluation:

Chief complaints:

Past History:

- H/o co-morbidities and drug intake :
- H/o previous surgery/(s) where difficult airway was encountered :
- Previous anaesthetic experience :

General physical examination:

Height (cm) : Weight (Kg) : BMI :

Pallor : Icterus :

Cyanosis : Clubbing : BP :

PR : RR : SpO2 :

Systemic examination:

RS: **CVS:**

CNS: **GIT:**

Airway Assessment:

Teeth: Jaw movements:

Investigations:

Hb (gm/dl): TLC: Platelet count:

Serum Creatinine**:** FBS: Chest x-ray: ECG:

Preoperative physical status: ASA Grade I II

Diagnosis:

Proposed surgery:

PRE-OPERATIVE AIRWAY PREDICTIVE TESTS	MEASURED VALUE/ GRADE
THYROMENTAL HEIGHT (TMH) (cm)	
THYROMENTAL DISTANCE (TMD) (cm)	
RATIO OF HEIGHT TO THYROMENTAL DISTANCE (RHTMD)	
MODIFIED MALLAMPATI TEST (MMT)	
MODIFIED CORMACK-LEHANE GRADING	

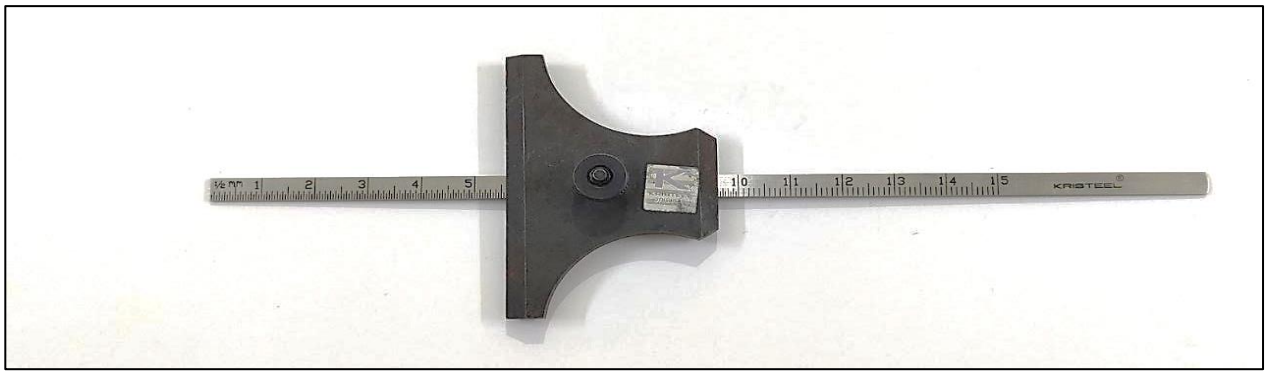
SIGNATURE OF THE ANAESTHESIOLOGIST: _____

SIGNATURE OF THE PRINCIPAL INVESTIGATOR: _____

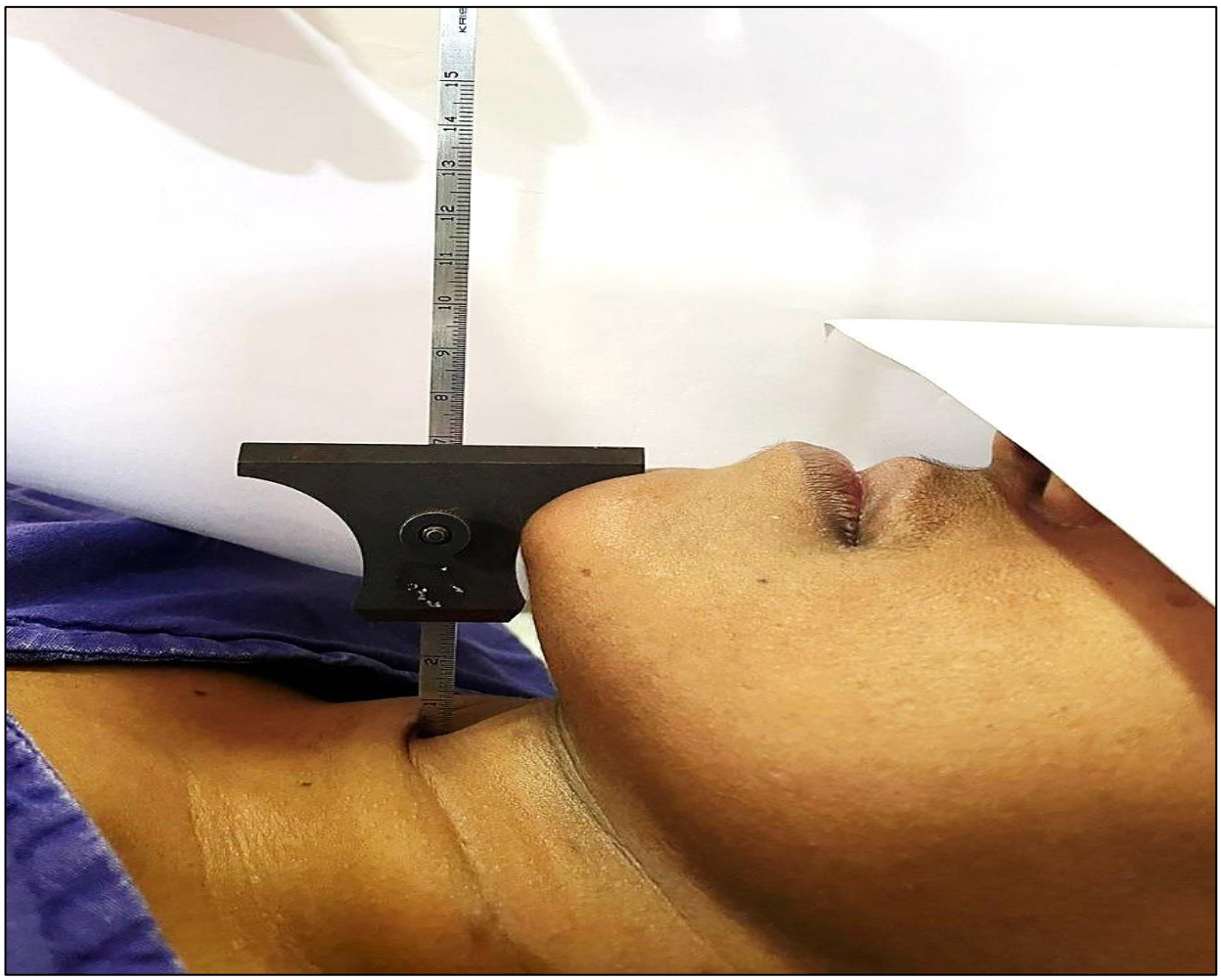
ANNEXURE III

PHOTOGRAPHS

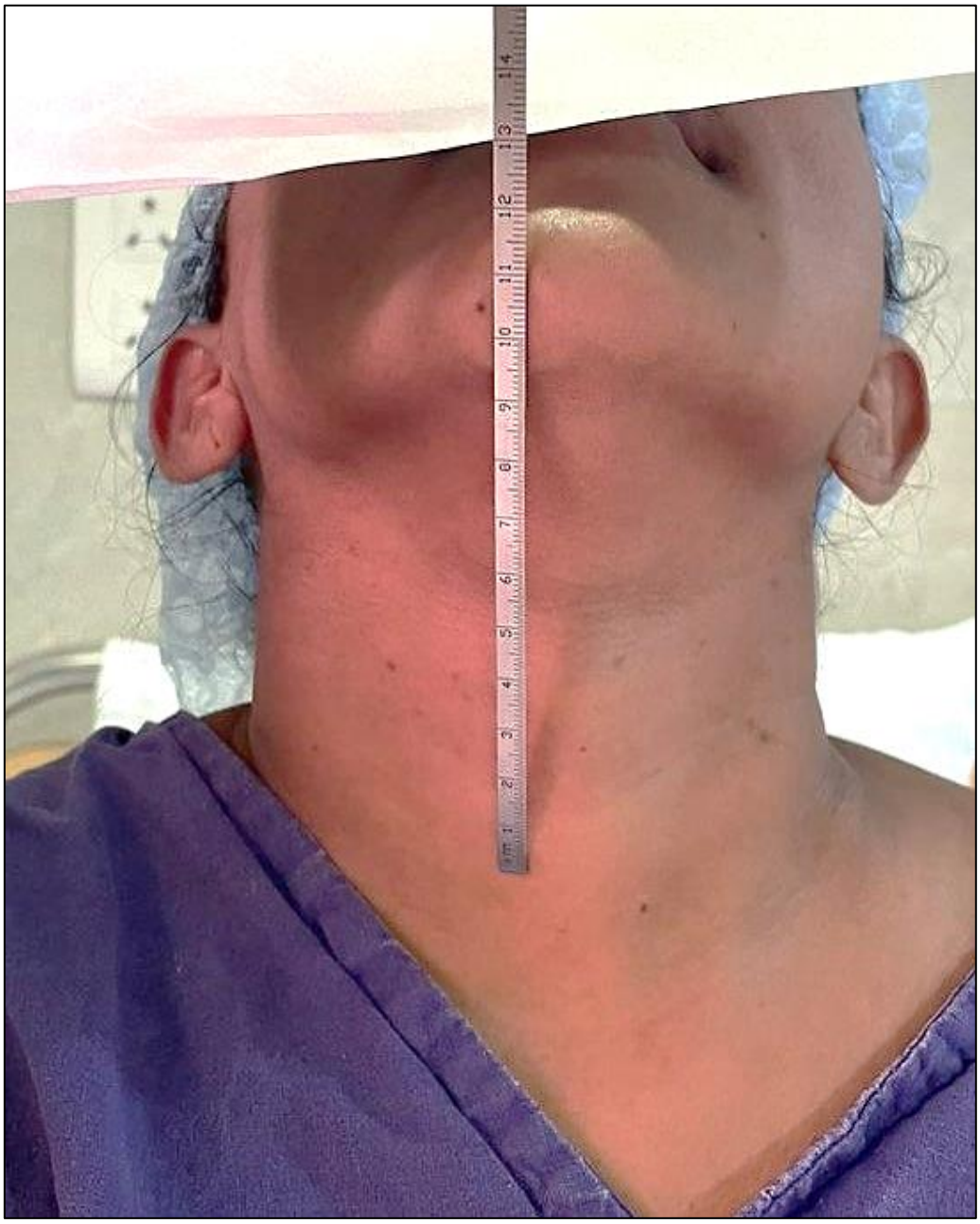
PHOTOGRAPH 1 – VERNIER DEPTH CALIPER



PHOTOGRAPH 2 – THYROMENTAL HEIGHT

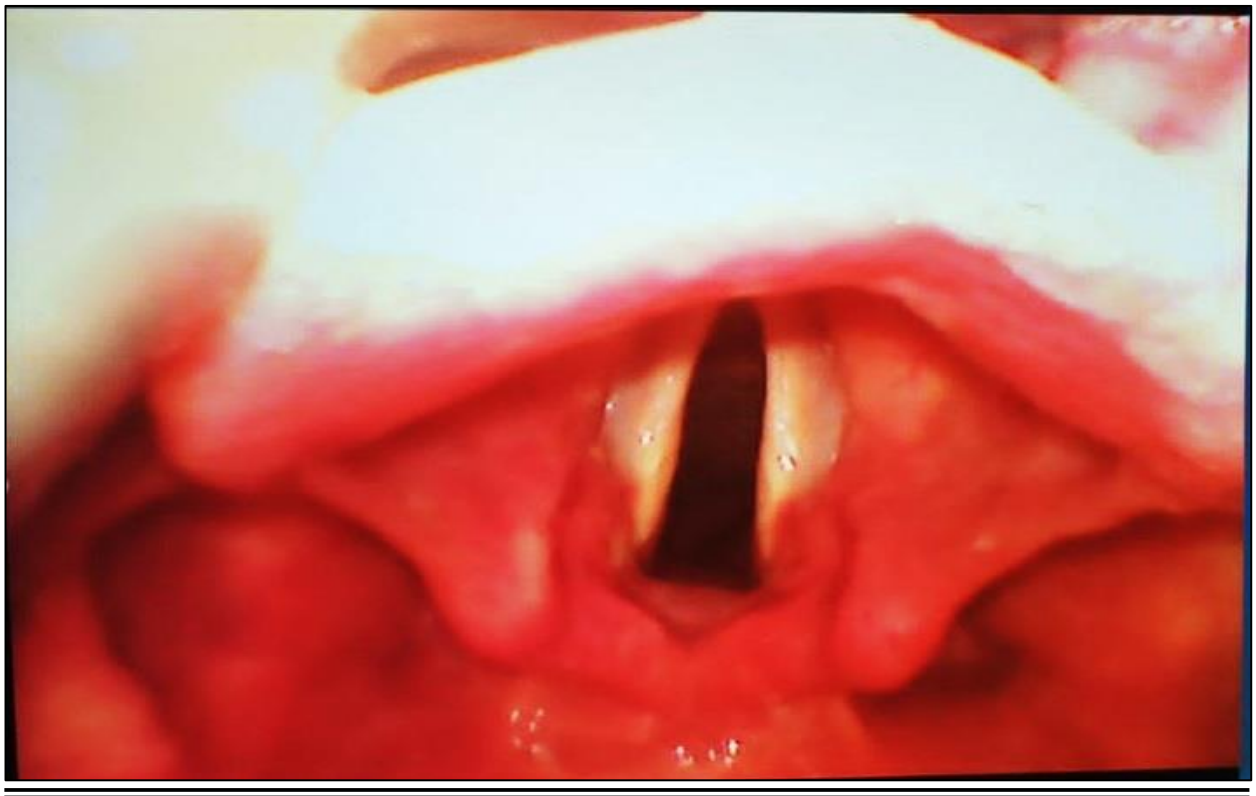


PHOTOGRAPH 3 – THYROMENTAL DISTANCE



PHOTOGRAPH 4 – MODIFIED MALLAMPATI TEST

PHOTOGRAPH 5 – MODIFIED CORMACK-LEHANE GRADING



ANNEXURE IV - MASTER CHART

					Baseline Data								Predictors of Difficult Airway													
Serial number	In patient number	Age in years	Sex	ASA Grade	Height (cm)	Weight (Kg)	BMI	HR (bpm)	SBP (mm Hg)	DBP (mm Hg)	Respiratory rate (cpm)	SpO2 (%)	Thyromental Height (cm)	Thyromental Distance (cm)	Ratio of Height to Thyromental Distance	Modified Mallampati Grade	Modified Cormack Lehane Grade	Intubation Difficulty	Thyromental Height (cm)	Intubation Difficulty	Thyromental Distance (cm)	Intubation Difficulty	Ratio of Height to Thyromental Distance	Intubation Difficulty	Modified Mallampati Grade	Intubation Difficulty
1	1043072	42	male	2	164	65	24.2	84	150	80	16	100	7.8	11.4	14.3	2	1	E	7.8	E	11.4	E	14.3	E	2	E
2	1045251	60	female	2	162	72	27.4	82	140	90	16	100	6.8	8.4	19.2	2	2a	E	6.8	E	8.4	E	19.2	E	2	E
3	1045670	21	female	1	158	60	24	78	110	70	16	100	6.5	8	19.75	1	1	E	6.5	E	8	E	19.75	E	1	E
4	1045577	55	female	2	155	99	41.25	76	130	80	18	99	5.7	9.5	16.3	3	3	D	5.7	D	9.5	E	16.3	E	3	D
5	1058946	40	male	1	175	64	21.3	88	130	80	16	100	7.4	10	17.5	1	1	E	7.4	E	10	E	17.5	E	1	E
6	1058956	46	male	1	168	57	20.3	84	120	70	14	100	6.4	10.5	16	1	1	E	6.4	E	10.5	E	16	E	1	E
7	1058986	48	male	2	166	66	24	90	140	90	14	100	7	11.5	14.4	2	3	D	7	E	11.5	E	14.4	E	2	E
8	1059248	46	male	2	170	65	22.5	96	130	80	16	99	6.3	7.2	23.6	3	3	D	6.3	E	7.2	E	23.6	D	3	D
9	1058371	23	female	1	156	52	21.4	90	110	70	14	100	7.2	9	17.3	2	2a	E	7.2	E	9	E	17.3	E	2	E
10	1058523	52	female	2	154	64	27	82	130	80	16	100	6	7.4	20.8	3	3	D	6	E	7.4	E	20.8	D	3	D
11	1058837	19	male	1	166	62	22.54	88	120	80	14	100	6.7	9.3	17.8	2	2b	D	6.7	E	9.3	E	17.8	E	2	E
12	1059072	57	male	2	168	74	26.24	76	140	80	14	100	5.8	8.2	20.4	3	3	D	5.8	D	8.2	E	20.4	E	3	D
13	1059580	18	female	1	158	56	22.4	92	100	70	14	100	6.8	11	14.3	2	2a	E	6.8	E	11	E	14.3	E	2	E
14	1059333	39	male	1	162	74	28.2	102	110	70	16	100	6.2	9.6	16.8	2	2a	E	6.2	E	9.6	E	16.8	E	2	E
15	1060234	60	male	2	168	74	26.4	86	150	90	16	98	6.1	7	24	3	3	D	6.1	E	7	E	24	D	3	D
16	1060642	36	female	1	156	58	23.8	68	110	70	16	99	6.4	7.8	20	2	1	E	6.4	E	7.8	E	20	E	2	E
17	1061676	19	male	1	171	46	15.75	78	120	80	16	100	6.4	11	15.5	1	1	E	6.4	E	11	E	15.5	E	1	E
18	1063071	45	female	1	152	48	20.87	104	100	60	16	100	6.5	8.4	18	3	2a	E	6.5	E	8.4	E	18	E	3	D
19	1063899	25	female	1	152	35	15.15	72	110	60	14	100	6.4	8.5	17.8	2	2a	E	6.4	E	8.5	E	17.8	E	2	E
20	1070129	31	female	1	152	55	23.9	82	130	80	14	100	7	10.6	14.3	1	2a	E	7	E	10.6	E	14.3	E	1	E
21	1069412	30	male	1	176	79	25.4	88	130	80	14	100	7.4	10	17.6	2	2a	E	7.4	E	10	E	17.6	E	2	E
22	1069568	50	female	1	164	62	23.4	96	100	80	14	99	6.8	8.4	19.5	2	1	E	6.8	E	8.4	E	19.5	E	2	E
23	1069668	48	female	1	168	63	22.3	80	130	80	14	100	6.8	10.2	16.4	2	2a	E	6.8	E	10.2	E	16.4	E	2	E
24	1069360	37	female	1	154	48	20.2	76	130	80	14	100	6.6	8.2	18.7	1	2a	E	6.6	E	8.2	E	18.7	E	1	E
25	1069821	42	female	1	168	84	29.78	92	110	80	14	100	5.6	6.7	25	3	2b	D	5.6	D	6.7	D	25	D	3	D

					Baseline Data								Predictors of Difficult Airway													
Serial number	In patient number	Age in years	Sex	ASA Grade	Height (cm)	Weight (Kg)	BMI	HR (bpm)	SBP (mm Hg)	DBP (mm Hg)	Respiratory rate (cpm)	SpO2 (%)	Thyromental Height (cm)	Thyromental Distance (cm)	Ratio of Height to Thyromental Distance	Modified Mallampati Grade	Modified Cormack Lehane Grade	Intubation Difficulty	Thyromental Height (cm)	Intubation Difficulty	Thyromental Distance (cm)	Intubation Difficulty	Ratio of Height to Thyromental Distance	Intubation Difficulty	Modified Mallampati Grade	Intubation Difficulty
26	1071064	29	female	1	162	58	22.14	76	110	60	14	100	6.8	9.4	17.2	2	2a	E	6.8	E	9.4	E	17.2	E	2	E
27	1072110	49	female	1	154	54	23.37	78	140	80	16	100	7.6	11	14	3	3	D	7.6	E	11	E	14	E	3	D
28	1072374	47	female	2	167	76	27.3	82	150	90	14	100	6.3	9	18.5	3	2a	E	6.3	E	9	E	18.5	E	3	D
29	1069375	30	female	2	156	62	25.51	74	110	70	14	100	6	7.8	20	2	1	E	6	E	7.8	E	20	E	2	E
30	1084230	45	male	1	166	50	18.1	76	100	70	16	100	5.6	7.5	22.1	3	2b	D	5.6	D	7.5	E	22.1	D	3	D
31	1084264	62	male	1	168	52	18.5	78	130	90	14	100	6	8.1	20.7	3	3	D	6	E	8.1	E	20.7	D	3	D
32	1084980	65	male	2	170	98	33.9	92	140	90	16	100	5	6.3	26.9	3	2a	E	5	D	6.3	D	26.9	D	3	D
33	1084916	19	female	1	150	35	15.5	86	130	80	16	100	6.4	7.8	19.2	2	2a	F	6.4	F	7.8	F	19.2	F	2	F
34	1083619	62	female	1	160	44	17.1	80	110	70	16	100	5.2	6.8	23.5	3	1	E	5.2	D	6.8	E	23.5	D	3	D
35	1085536	26	female	1	170	74	25.6	82	120	70	14	100	6.8	8.3	20.4	2	2a	E	6.8	E	8.3	E	20.4	E	2	E
36	1085096	58	female	1	168	54	19.6	70	140	80	16	100	6.3	7.8	21.5	2	2a	E	6.3	E	7.8	E	21.5	D	2	E
37	1085798	38	male	1	160	85	33.4	90	140	80	16	98	5.2	6.7	23.8	3	2a	E	5.2	D	6.7	D	23.8	D	3	D
38	1086780	26	female	1	166	67	26.1	100	120	80	16	100	5.6	6.9	24	2	1	E	5.6	D	6.9	E	24	D	2	E
39	1086670	32	female	1	164	58	21.6	62	110	70	14	100	7.4	10.2	16	1	1	E	7.4	E	10.2	E	16	E	1	E
40	1087152	45	male	2	174	82	27.3	70	140	90	16	100	5	6.5	26.7	3	3	D	5	D	6.5	D	26.7	D	3	D
41	1087803	37	female	2	156	63	26.25	84	130	80	14	98	6.8	9.3	16.7	2	1	E	6.8	E	9.3	E	16.7	E	2	E
42	1089572	50	female	2	167	76	27.34	86	110	70	14	100	6.5	8.2	20.3	2	2a	E	6.5	E	8.2	E	20.3	E	2	E
43	1089575	32	female	2	164	70	26	86	140	80	14	100	6.4	8.2	20	2	1	E	6.4	E	8.2	E	20	E	2	E
44	1089595	35	female	1	162	56	21.3	70	100	70	14	100	7.2	9.8	16.5	2	2a	E	7.2	E	9.8	E	16.5	E	2	E
45	1090370	42	male	1	165	66	24.4	82	120	80	16	100	6	9.5	17.3	2	2a	F	6	F	9.5	F	17.3	F	2	F
46	1089106	55	female	2	163	58	21.8	88	140	90	16	100	7.8	11	14.8	3	2a	E	7.8	E	11	E	14.8	E	3	D
47	1090190	54	male	2	172	64	21.6	84	130	80	14	100	7.4	10.2	16.8	2	2a	F	7.4	F	10.2	F	16.8	F	2	F
48	1091711	50	female	1	160	67	26.1	76	120	80	16	100	6.8	9.6	16.6	2	2a	E	6.8	E	9.6	E	16.6	E	2	E
49	1091914	65	female	2	164	80	29.74	78	130	90	14	100	5.9	6.4	25.6	3	2a	E	5.9	E	6.4	D	25.6	D	3	D
50	1088798	60	female	2	158	50	20	82	130	90	16	100	6.4	8	19.75	2	2b	D	6.4	E	8	E	19.75	E	2	E

					Baseline Data								Predictors of Difficult Airway													
Serial number	In patient number	Age in years	Sex	ASA Grade	Height (cm)	Weight (Kg)	BMI	HR (bpm)	SBP (mm Hg)	DBP (mm Hg)	Respiratory rate (cpm)	SpO2 (%)	Thyromental Height (cm)	Thyromental Distance (cm)	Ratio of Height to Thyromental Distance	Modified Mallampati Grade	Modified Cormack Lehane Grade	Intubation Difficulty	Thyromental Height (cm)	Intubation Difficulty	Thyromental Distance (cm)	Intubation Difficulty	Ratio of Height to Thyromental Distance	Intubation Difficulty	Modified Mallampati Grade	Intubation Difficulty
51	1092007	48	male	2	162	55	20.9	84	130	80	14	100	7.4	11.2	14.5	2	2a	E	7.4	E	11.2	E	14.5	E	2	E
52	1092411	50	female	2	156	62	25.5	88	130	80	14	100	6.8	8.2	19	2	2b	D	6.8	E	8.2	E	19	E	2	E
53	1092305	55	male	2	160	70	27.3	96	140	80	14	99	6	7.2	22.2	3	3	D	6	E	7.2	E	22.2	D	3	D
54	1093692	43	female	1	168	63	22.3	80	130	80	14	100	6.8	10.2	16.4	2	2a	E	6.8	E	10.2	E	16.4	E	2	E
55	1093705	46	female	1	154	48	20.2	76	130	80	14	100	6.6	8.2	18.7	1	2a	E	6.6	E	8.2	E	18.7	E	1	E
56	1093631	42	female	2	158	84	33.7	92	130	90	16	99	5.6	6.2	25.4	4	3	D	5.3	D	6.2	D	25.4	D	4	D
57	1093589	50	female	1	162	58	22.14	76	110	60	14	100	6.8	9.4	17.2	2	2a	E	6.8	E	9.4	E	17.2	E	2	E
58	1094252	27	female	1	154	54	23.37	78	140	80	16	100	7.6	11	14	2	2a	E	7.6	E	11	E	14	E	2	E
59	1095060	70	male	2	167	76	27.3	82	150	90	14	100	6.3	9	18.5	3	3	D	6.3	E	9	E	18.5	E	3	D
60	1095053	33	female	1	156	62	25.51	74	110	70	14	100	6	7.8	20	2	1	E	6	E	7.8	E	20	E	2	E
61	1095033	52	female	2	166	50	18.1	76	130	80	16	100	5.6	7.5	22.1	3	2a	E	5.5	D	7.5	E	22.1	D	3	D
62	1095269	41	male	2	168	52	18.5	78	130	90	14	100	6	8.1	20.7	3	2a	E	6	E	8.1	E	20.7	D	3	D
63	1095231	19	male	1	170	78	26.9	92	120	70	16	100	6.2	7.4	22.9	2	2a	E	6.2	E	7.4	E	22.9	D	2	E
64	1097107	20	female	1	150	35	15.5	86	130	80	16	100	6.4	7.8	19.2	2	2a	E	6.4	E	7.8	E	19.2	E	2	E
65	1096152	50	male	2	160	44	17.1	80	140	70	16	100	5.2	6.5	24.6	3	2a	E	5.2	D	6.5	D	24.6	D	3	D
66	1097983	30	male	1	170	74	25.6	82	120	70	14	100	6.8	8.3	20.4	2	2a	E	6.8	E	8.3	E	20.4	E	2	E
67	1096898	63	male	2	175	64	21.3	88	130	90	16	100	7.4	10	17.5	1	2a	E	7.4	E	10	E	17.5	E	1	E
68	1097937	58	male	1	168	57	20.3	84	120	70	14	100	7.2	10.5	16	1	1	E	7.2	E	10.5	E	16	E	1	E
69	1097914	56	male	2	166	66	24	90	140	90	14	100	7	11.5	14.4	2	2a	E	7	E	11.5	E	14.4	E	2	E
70	1098159	55	female	1	170	65	22.5	96	130	80	16	99	6.3	7.2	23.6	2	2a	E	6.3	E	7.2	E	23.6	D	2	E
71	1104289	23	female	1	156	52	21.4	90	110	70	14	100	7.2	9	17.3	2	3	D	7.2	E	9	E	17.3	E	2	E
72	1104615	60	male	2	162	64	24.4	82	140	80	16	100	6	7.4	20.8	3	2a	E	6	E	7.4	E	20.8	D	3	D
73	1106207	30	female	2	166	62	22.54	88	120	80	14	100	6.7	9.3	17.8	2	2b	D	6.7	E	9.3	E	17.8	E	2	E
74	1100670	38	male	1	168	74	26.24	76	130	80	16	99	5.8	8.2	20.4	2	3	D	5.8	D	8.2	E	20.4	E	2	E
75	1106289	18	female	1	158	56	22.4	92	100	70	14	100	6.8	11	14.3	2	2a	E	6.8	E	11	E	14.3	E	2	E

					Baseline Data								Predictors of Difficult Airway													
Serial number	In patient number	Age in years	Sex	ASA Grade	Height (cm)	Weight (Kg)	BMI	HR (bpm)	SBP (mm Hg)	DBP (mm Hg)	Respiratory rate (cpm)	SpO2 (%)	Thyromental Height (cm)	Thyromental Distance (cm)	Ratio of Height to Thyromental Distance	Modified Mallampati Grade	Modified Cormack Lehane Grade	Intubation Difficulty	Thyromental Height (cm)	Intubation Difficulty	Thyromental Distance (cm)	Intubation Difficulty	Ratio of Height to Thyromental Distance	Intubation Difficulty	Modified Mallampati Grade	Intubation Difficulty
76	1107307	20	female	1	162	60	22.9	102	110	70	16	100	6.2	9.6	16.8	2	2a	E	6.2	E	9.6	E	16.8	E	2	E
77	1107101	63	male	2	168	74	26.4	86	150	80	16	98	6.1	6.2	27	3	3	D	6.1	E	6.2	D	27	D	3	D
78	1107626	33	female	1	156	58	23.8	68	110	70	16	99	6.4	7.8	20	2	2a	E	6.4	E	7.8	E	20	E	2	E
79	1107571	45	female	1	154	46	19.4	78	120	80	16	100	5.8	7.4	20.8	2	2a	E	5.8	D	7.4	E	20.8	D	2	E
80	1107591	25	female	1	152	48	20.87	104	100	60	16	100	6.5	8.4	18	2	3	D	6.5	E	8.4	E	18	E	2	E
81	1107731	45	female	1	160	52	20.3	72	110	60	14	100	6.4	8.5	18.8	2	3	D	6.4	E	8.5	E	18.8	E	2	E
82	1107817	47	female	2	170	74	25.6	82	120	70	14	100	6.8	8.3	20.4	3	3	D	6.8	E	8.3	E	20.4	E	3	D
83	1108449	59	male	1	168	54	19.6	70	120	80	16	100	6.3	7.8	21.5	2	2a	E	6.3	E	7.8	E	21.5	D	2	E
84	1107683	45	male	2	160	85	33.4	90	140	80	16	98	5.2	6.3	25.3	3	3	D	5.1	D	6.3	D	25.3	D	3	D
85	1107907	70	male	2	166	67	26.1	100	150	90	16	100	5.6	6.5	25.5	2	1	E	5.8	E	6.5	D	25.5	D	2	E
86	1107522	66	male	2	164	58	21.6	62	140	70	14	100	7.4	10.2	16	1	1	E	7.4	E	10.2	E	16	E	1	E
87	1108701	38	female	1	170	68	23.5	70	120	70	16	100	5.2	6.4	26.5	3	3	D	5.2	D	6.4	D	26.5	D	3	D
88	1108748	42	female	2	156	63	26.25	84	130	80	14	98	6.8	9.3	16.7	2	2a	E	6.8	E	9.3	E	16.7	E	2	E
89	1109083	60	male	2	167	76	27.34	86	110	70	14	100	6.5	8.2	20.3	2	2a	E	6.5	E	8.2	E	20.3	E	2	E
90	1107985	20	female	1	154	48	20.2	86	100	80	14	99	6.2	7.5	20.5	2	1	E	6.2	E	7.5	E	20.5	D	2	E
91	1108922	45	female	2	162	56	21.3	70	130	90	14	100	7.2	9.8	16.5	2	2a	E	7.2	E	9.8	E	16.5	E	2	E
92	1110198	48	male	1	165	66	24.4	82	120	80	16	100	6	9.5	17.3	2	2a	E	6	E	9.5	E	17.3	E	2	E
93	1110356	59	male	2	163	58	21.8	88	140	90	16	100	7.8	11	14.8	3	2b	D	7.8	E	11	E	14.8	E	3	D
94	1110718	30	female	1	158	53	21.2	84	120	80	14	100	7.4	9	17.5	2	2a	E	7.4	E	9	E	17.5	E	2	E
95	1110834	36	female	1	160	67	26.1	76	120	80	16	100	6.8	9.6	16.6	2	3	D	6.8	E	9.6	E	16.6	E	2	E
96	1110475	47	male	2	164	60	22.3	78	140	90	14	99	5.9	6	27.3	3	3	D	5.9	E	6	D	27.3	D	3	D
97	1110963	46	female	2	158	50	20	82	130	90	16	100	6.4	8	19.75	2	2a	E	6.4	E	8	E	19.75	E	2	E
98	1112409	70	male	2	168	72	25.7	82	150	80	14	98	7	10.6	15.8	1	2a	E	7	E	10.6	E	15.8	E	1	E
99	1112556	54	male	1	176	79	25.4	88	120	80	14	100	7.4	10	17.6	2	2a	E	7.4	E	10	E	17.6	E	2	E
100	1111833	44	male	2	164	59	22	90	110	70	14	99	6.5	8.4	19.5	2	2a	E	6.5	E	8.4	E	19.5	E	2	E

E - EASY intubation
D - DIFFFICULT intubation

ANNEXURE V – KEY TO MASTER CHART

ASA	-	American Society of Anaesthesiologists
BMI	-	Body Mass Index
bpm	-	Beats per minute
cpm	-	Cycles per minute
cm	-	Centimeter
DBP	-	Diastolic Blood Pressure
HR	-	Heart Rate
Kg	-	Kilogram
mmHg	-	Millimeter of mercury
SBP	-	Systolic Blood Pressure
SpO_2	-	Peripheral capillary Oxygen Saturation