EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: PROSPECTIVE OBSERVATIONAL STUDY

By

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ABBREVIATIONS

ETT - Endotracheal Tube

GA - General Anaesthesia

mm - millimetre

cm - centimeter

ASA - American Society of Anaesthesiologists

ECG - electrocardiogram

NIBP - Non-invasive Blood Pressure

SPO2 - Oxygen Saturation

S.D - Standard Deviation

min - Minutes

n - Number of Subjects

p - 'p' value

Sl. No. - serial no

BMI - Body Mass Index

BURP - Backward upward rightward pressure

DL - Direct Laryngoscope

USG - ultrasonography

DSE - Distance from skin to epiglottis

DSHB - Distance from skin to hyoid bone

MMG - Modified Mallampatti score

TMD - Thyromental distance

CL - Cormack Lehane Grading

ABSTRACT

Background and aims

Unanticipated difficult intubation poses a challenge in routine practice for anesthesiologists. A preoperative airway evaluation helps in the identification of a difficult airway. Difficult laryngoscopy followed by tracheal intubation rate remain at 1.5 - 13% despite using multiple clinical screening tests. Ultrasonography is a reliable tool for airway assessment to predict difficult airway. In this study we evaluate ultrasonography parameters with conventional clinical parameters for predicting difficult airway in adults posted for elective surgeries under general anaesthesia.

Methods

In this prospective randomised clinical trial, 72 adults with ASA I and II requiring endotracheal intubation for surgeries under general anaesthesia, enrolled and randomised following which Modified Mallampatti score and thyromental distance as well as ultrasound distance from skin to epiglottis (DSE) and distance from skin to hyoid bone (DSHB) were measured and they were categorised into easy and difficult airway groups. The primary objective was the evaluation of ultrasonographic parameters for difficult laryngoscopy prediction. The secondary objective was to measure the distance of skin to epiglottis (DSE) and distance of skin to the hyoid bone (DSHB) using USG followed by conventional screening tools such as modified mallampatti score and thyromental distance in the prediction of difficult laryngoscopy.

Results

DSE had the highest sensitivity and specificity of 90.48% and 84.8% respectively. DSHB had a higher sensitivity and specificity of 80.95% and 76.47% respectively than thyromental distance which had a sensitivity of 71.43% and 66.67% respectively. Modified Mallampatti grading had least sensitivity and specificity of 66.67% and 60.78% respectively.

Conclusion

The results of this study showed that ultrasonographic measurements of soft tissue thickness at the thyrohyoid and hyoid level have higher sensitivity and specificity than the clinical parameters for airway assessment.

Keywords-

Airway management, Ultrasonography, Difficult Laryngoscopy.

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INTRODUCTION

Endotracheal intubation has a major role in airway maintenance and adequate ventilation during general anaesthesia as well as in resuscitation scenario.[1]

Inability to secure the airway is one of the major causes of morbidity and mortality for patients.[2] Hence unanticipated difficult intubation poses a challenge in routine practice for anaesthesiologists.[3] Difficult airway lacks an accepted standard definition, but it mainly comprises of different aspects of airway management such as difficult mask ventilation, difficult/unsuccessful intubation and difficult laryngoscopy. The definition of difficult intubation also lacks accord but is commonly concluded from the ease of laryngoscopy such as the Cormack–Lehane Grade.[4]

Assessment of the airway is a prerequisite for anaesthesiologist as it helps to identify a difficult airway, thereby providing time for adequate preparation such as the proper selection of equipment and technique for the same. Securing airway is vital to maintain adequate oxygenation as well as ventilation. Airway mismanagement leads to devastating consequences for both the patients and the providers. Oesophageal intubation, inadequate ventilation, and difficult tracheal intubation are the very common mechanisms of adverse respiratory outcomes in the anaesthesiology practice.[5]

Difficult laryngoscopy remains high despite using multiple clinical screening tests such as modified Mallampatti classification, jaw movement, sternomental distance, inter incisor gap, thyromental distance, Wilson score, and LEMON score. Most of them have low predictive values.[4,6,7] Cormack Lehane grading can be used to classify and identify difficult intubation, but it being a procedure which is invasive, it cannot be included in the pre-anaesthetic evaluation. Therefore a comprehensive examination of airway that incorporates both qualitative and quantitative tests increases the probability of difficult laryngoscopy prediction. Hence it is important to find a sensitive and specific method of airway assessment as an adjuvant to the daily used clinical methods.[5]

Future applications of ultrasonography in the practice of anaesthesia are wide and comprises of chronic pain procedures, vascular access, lung ultrasound, neuro-monitoring, regional anaesthesia, airway assessment, gastric ultrasound, focused transthoracic echography and vascular Doppler flow assessment. Inter-observer variability is a definitive disadvantage, and that it requires training and experience to be skilled in the technology. Development of a thorough understanding of the sonoanatomy is critical in order to be successful with this technique. The structures both normal and abnormal need to be imaged and interpreted before any intervention. Recently ultrasonography has gained popularity in perioperative airway management.[4]

Ultrasound can be used as a reliable tool for airway assessment, which is portable, non invasive and has the similar efficacy to a CT scan in assessing dimensions of airway structure without any radiation exposure risk. It has various clinical applications in the upper airway, such as ET tube size prediction, identification of the endotracheal tube position and determining laryngeal mask position.[1,3] The fat pads are hypothesised to affect the direct laryngoscopy view, so the increased thickness of soft tissue at the pre tracheal or pre-epiglottic space could be considered to be good predictors of difficult laryngoscopy. Upon this, recent studies have used the measurement of thickness of anterior soft tissue of neck such as distance of skin to hyoid bone and distance between skin to epiglottis, to be a good predictors of difficult laryngoscopy and showed the correlation of difficult laryngoscopy with different ultrasonography parameters.[4,8]

Several studies have been done on the use of ultrasound in predicting difficult laryngoscopy, but very few studies have evaluated the use of ultrasonography with the conventional screening methods in determining difficult laryngoscopy in adult patients posted for surgeries under general anaesthesia.

Hence the present study was conducted to know if the ultrasonographic estimation is better than the conventional screening tools used in adult patients to predict difficult laryngoscopy under general anaesthesia.

AIMS AND OBJECTIVES

AIM: To evaluate ultrasonography parameters (USG) with conventional clinical parameters for predicting difficult airway in adults posted for elective surgeries under general anaesthesia

OBJECTIVE:

Primary objective

- Evaluation of ability of ultrasound parameters in difficult laryngoscopy prediction.

Secondary objective

- Measurement of ultrasonographic parameters such as the distance between skin to epiglottis (DSE) and distance from skin to the hyoid bone (DSHB) for difficult laryngoscopy prediction.
- Assessment of conventional clinical parameters such as modified mallampatti grading and thyromental distance in prediction of difficult laryngoscopy

REVIEW OF LITERATURE

Jinhong Wu *et al*. (2014)[1] conducted a study in 203 adult patients who were posted for elective surgery under general anaesthesia to determine the possibility of predicting difficult laryngoscopy using measurements of soft tissue thickness in the neck at the level of the hyoid bone, anterior commissure and thyrohyoid membrane anteriorly with ultrasound and correlation with clinical screening tools such as thyromental distance, inter incisor gap and Modified Mallampatti score. The study revealed that ultrasonographic measurements of anterior neck soft tissue at the level of the hyoid bone, thyrohyoid membrane, and anterior commissure levels are independent parameters of a difficult airway. Hence the combination of clinical screening tests with ultrasonographic results may increase the prediction probability of difficult airway.

Hongwei Ni *et al*. (2020)[2] conducted a study in 215 patients to assess the measurement of laryngeal structures and determine the usefulness in predicting difficult laryngoscopy. Ultrasonographic measurement of the distance from skin and thyroid cartilage, the distance from the thyroid cartilage and epiglottis, and the distance from skin and epiglottis done and were then used to predict easy versus difficult laryngoscopy. It was concluded that DSE is an independent predictor for difficult laryngoscopy and also as a better predictor than other ultrasound or clinical measurements for predicting difficult laryngoscopy.

B.S. Abdelhady *et al*. (2020)[3] did a single-blinded prospective randomized study in eighty patients to evaluate distance between skin and epiglottis distance measurement sonographically for predicting difficulty in laryngoscopy in the Egyptian population.

Preoperatively airway evaluation was done using modified Mallampatti grading, thyromental distance, and ultrasonographically measured distance between skin and epiglottis (DSE). The study revealed not only a strong association between sonographic measurement of DSE and difficult laryngoscopy but also to be a more reliable parameter than clinical airway assessment tests.

Vishal Koundal *et al.* (2019)[4] conducted an observational study in 200 patients requiring orotracheal intubation and general anaesthesia for assessing the potential of the ultrasound to be a reliable airway assessment tool in predicting difficult laryngoscopy. Anterior neck soft tissue thickness was measured using ultrasound and used to predict difficulty in laryngoscopy and then correlate findings with the Cormack Lehane grading. The study concluded ultrasound to have more accuracy and correlation in prediction of Cormack Lehane grading and hence should be used in the pre-anaesthetic evaluation of the airway.

Nabin K Yadav *et al.* (2019)[6] did an observational study in 310 adult patients to observe the usefulness of ultrasonography measured thickness of anterior soft tissue of the neck, and tongue thickness for predicting difficult laryngoscopy and comparison to clinical parameters for airway assessment. The study concluded that measurements of anterior soft tissues of neck and tongue thickness had higher sensitivity and specificity than clinical airway parameters, and hence the combination of both helps in better prediction of difficult laryngoscopy.

Joti Kanoujiya *et al.* (2019)[7] conducted a study in 100 adult patients posted for elective surgery under general anaesthesia and intubated using direct laryngoscopy. It aimed at prediction of difficult laryngoscopy by measuring thickness of neck soft tissue anteriorly using ultrasound. Modified Mallampatti score, circumference of neck, Thyromental distance, BMI and distance from skin to hyoid bone as well as the distance of skin to anterior commissure of vocal cords using ultrasound assessed which was followed by Cormack Lehane grading on laryngoscopy. It was concluded that even though BMI, Modified Mallampatti grade, and circumference of neck are good in predicting difficult laryngoscopy, the ultrasound guided measurements done at the hyoid bone level and anterior commissure of vocal cords showed greater specificity and sensitivity for same.

Dr.Saranya *et al.* (2017)[8] conducted a study in 141 adult patients who were to undergo elective surgery under general anaesthesia and endotracheal intubation to determine the advantage of ultrasonography preoperatively for difficult airway assessment. Preoperatively ultrasonographic assessment of the thickness of anterior soft tissue done at the level of the hyoid bone, thyrohyoid membrane, and suprasternal notch. Based on this study, it was concluded that there was a significant correlation between soft tissue thickness at the level of thyrohyoid membrane and difficulty in intubation.

Aruna Parameswari *et al* (2017)[9] conducted a study in one hundred and thirty patients posted for elective surgeries under general anaesthesia and intubated with direct laryngoscopy. Clinical as well as ultrasonographic airway assessment was done preoperatively to predict the difficulty in laryngoscopy and then the Cormack Lehane grade was noted during laryngoscopy. The distance of skin to epiglottis, as measured using ultrasound was found to be a good parameter to predict difficulty in laryngoscopy. When this measurement was combined with the modified Mallampati score, the sensitivity was found to be higher than any single airway assessment parameter taken alone.

Sussan Soltani Mohammadi *et al* (2019)[10] conducted a study in 60 patients posted for elective surgeries under general anaesthesia. It revealed there is a good association between ultrasonographic measured distance of skin to epiglottis and of epiglottis to mid - vocal cord with Cormack Lehane grading in patients undergoing general anaesthesia for difficult intubation prediction. Therefore the measurement criteria using ultrasound may be helpful in airway examination before anaesthesia for predicting of difficult intubation.

Preeti B Reddy *et al* (2016)[11] studied one hundred patients undergoing elective surgery under general anaesthesia. Mallampati grading, thyromental distance and sternomental distance were noted as well as the ultrasonographic measurements of the soft tissue thickness of neck at the level of the hyoid , the level of the vocal cords (ANS-VC) and the ratio of the depth of the pre-epiglottic space to the distance of the epiglottis to the mid-point of the distance between the vocal cords and then the CL grade was noted during laryngoscopy. It was concluded that the measurement of the ANS-VC is a potential tool in airway assessment and a thickness of more than 0.23 cm correlated with the prediction of difficult intubation.

Dr. Tjokorda Gde Agung Senapathi et al (2020)[12] conducted a study in 128 adult patients who underwent surgery electively under general anaesthesia. The skin to epiglottis distance of the patients were examined using ultrasound and after direct laryngoscopy after induction of anaesthesia , the Cormack–Lehane grading was noted for each patient. The skin-to-epiglottis distance between easy and difficult intubation was given a cut off value of 26.05 mm. The sensitivity was 69.4% and specificity was 93.5% of this method to predict difficult airway . Therefore they concluded that skin to epiglottis distance of > 26.05 mm to be considered a risk factor for difficult intubation.

Sumidtra Prathep et al (2022)[13] studied 88 morbidly obese patients (BMI $\geq$ 35 kg/m^2) undergoing elective surgeries under general anaesthesia with endotracheal intubation. Preoperatively, measurements like body mass index, neck circumference, inter incisor distance, sternomental distance, thyromental distance, modified Mallampati scoring, upper lip bite test and distance from skin to epiglottis were taken. The laryngoscopic view was graded on the Cormack and Lehane score. The study concluded that age, thyromental distance and ultrasonography for the distance from skin to epiglottis can predict difficult laryngoscopy among obese Thai patients.

Mehran Sotoodehnia et al (2021)[14] conducted meta-analysis and systemic review of the performance of ultrasonography in difficult airway assessment. 371 articles were assessed and from 26 articles data was collected, which determined 45 ultrasound indicators for prediction of difficult intubation. The most common US index was the “thickness of anterior neck soft tissue at the vocal cords level”. “Skin to epiglottis” and “anterior neck soft tissue at the hyoid bone level” were the most commonly used indicators in this area. This review showed that ultrasounography can be invariably used for prediction of difficult airway and that “skin thickness at the epiglottis and hyoid levels”, “the hyomental distance” and “the hyomental distance ratio” were correlated with difficult cases of laryngoscopy in the study.

Stefano Falcetta et al (2020)[(15)] conducted an observational study in 301 patients who were posted for elective surgery under general anaesthesia to determine the association of ultrasound measurements of soft tissues thickness of neck anteriorly and Cormack-Lehane grade view noted during direct laryngoscopy where patients had undergone normal airway assessment tests. The thickness of the soft tissues was measured at the vocal cord and thyrohyoid level and the Cormack Lehane was noted. They concluded airway ultrasound can be used for the prediction of unanticipated difficult airway and for patients with difficulty in laryngoscopy.

Francesco Alessandri et al (2019)[(16)] studied 194 patients posted for elective surgery with general anaesthesia to assess the potential of ultrasound preoperatively for the prediction of difficult airway. Distances measured using ultrasound from the isthmus of thyroid to skin, the hyoid bone and skin, the skin and epiglottis and the skin and anterior commissure of the vocal cords. The measured distances were more for patients who had difficulty in laryngoscopy and difficulty in mask ventilating. This study confirmed the association between thickness of neck soft tissues and difficulty in mask ventilating and laryngoscopy.

Srikar Adhikari et al (2011)[(17)] did a prospective observational study in 51 adult patients undergoing endotracheal intubation for an elective surgical procedure to observe the use of ultrasound to differentiate difficult from easy laryngoscopy and for determining the correlation between the ultrasound parameters and the clinical airway assessment routinely used. This was done by measuring the tongue thickness, anterior soft tissue at the hyoid and thyrohyoid. The study noted that the measurements of thickness of soft tissue can be used for assessing the ease of laryngoscopy. Clinical conventional screening tests could not be correlated to measurements acquired using ultrasonography, and also ultrasonographic measurements were able to detect difficulty in laryngoscopy, thereby indicating the limitations of the conventional clinical tests for prediction of difficult laryngoscopy.

ANATOMY AND PHYSIOLOGY OF THE UPPER AIRWAY

The upper part of airway has a major responsibility in normal respiration which is a highly detailed neurophysiological process. Both the anatomy and the functions influence the exchange of inspired and expired air. The upper part of airway is from the mouth to the trachea which comprises of the nose, pharynx, palate, uvula, mouth and the larynx. Knowledge about functional anatomy of the airway is important to the anaesthesiologist to maintain the normal airway. The airway is divided into :-

Upper airway is subdivided in to nasal and oral cavity, pharynx and larynx.

Lower airway consists of tracheobronchial tree. [18]

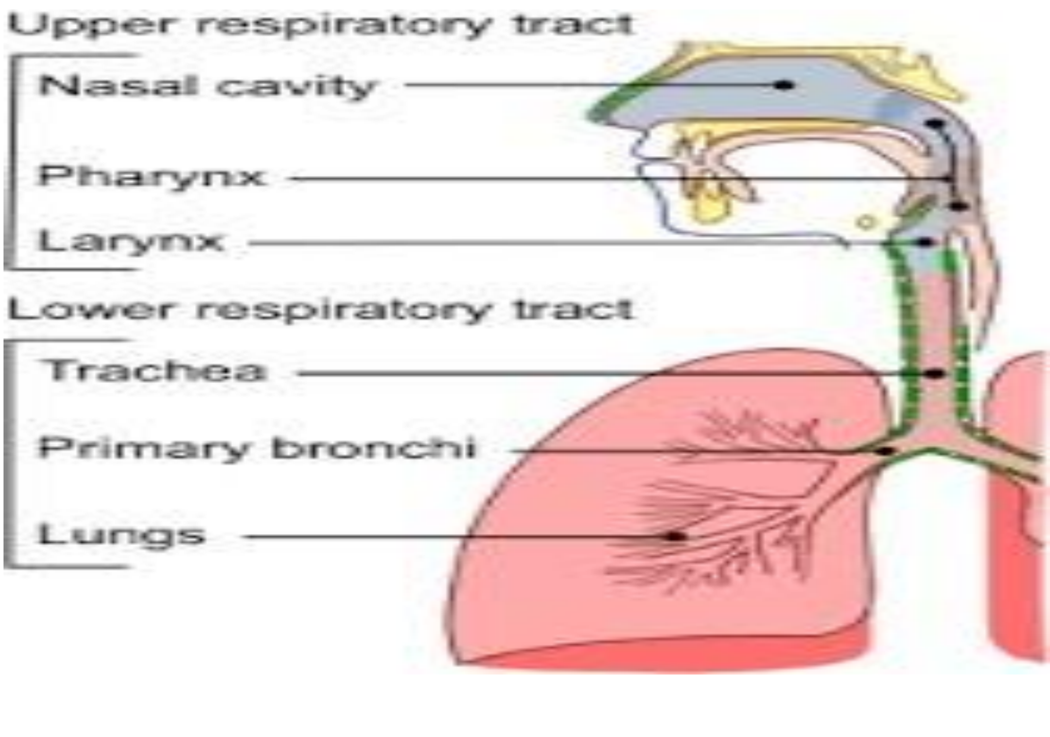


Figure 1 : Anatomical structures in upper and lower airway

UPPER AIRWAY

NOSE

The outer part of the nose is by the nasal bones, the cartilaginous part of the nasal septum, upper and lowers lateral cartilages and skin. Nostrils are separated by the nasal septum and columella. The upper portion of the nose has a framework which is formed by the two nasal bones. The vomer forms the inferior and the ethmoid plate forms the superior part of the bones of the posterior septum. Cartilage supports the lower portion of the nose.[(18,19,20)]

NASAL CAVITY

The nasal septum divides the nasal cavity into two passages. The vertical plate of ethmoid, the vomer and the septal cartilage forms the nasal septum. Each nasal fossa is formed by a roof , a floor, nasal septum as the medial wall and a lateral wall, opened anteriorly by anterior nares, posteriorly opened in to nasopharynx by the choana. Nasal vestibule is the anterior aspect of the nasal cavity located above each anterior nares. Medial and lateral crura of the alar cartilage surrounds the nares and vestibule. Medial wall of the vestibule is formed by the anterior part of the cartilaginous septum and the columella(connective tissue septum) , the lateral portion contains the coarse hairs-the vibrissae in the skin which protects the nasal opening and filters the inhaled air.[(18,19,20)]

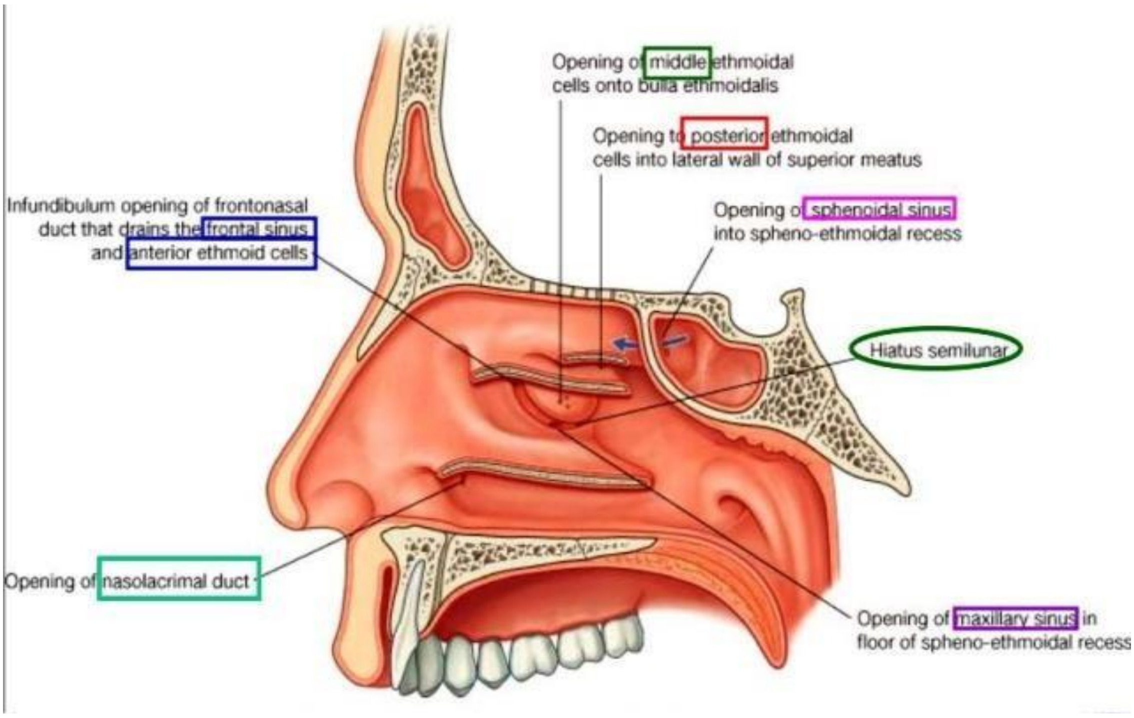


Figure 2: Shows the opening of all sinuses in the lateral wall of nose.

Lateral wall: It comprises of irregular projections made of bone and has a soft tissue and mucous membrane covering. The projections are called the middle, superior, inferior and supreme nasal conchae or turbinates. Meatus is the space under each turbinate. The structure of supreme, superior and middle turbinates is derived from the ethmoid bone. A separate bone gives the inferior turbinate its shape. Ostia of paranasal sinuses and the nasolacrimal duct is in the lateral wall. The inferior meatus has the opening of the nasolacrimal duct which is located almost 3cm behind the nasal opening. The middle meatus contains the opening of nasofrontal duct, maxillary sinus and the middle turbinate. The posterior ethmoid cells opens into the superior meatus. The sphenoid opening is in the sphenoid sinus wall which is located anteriorly in the region of the sphenoethmoidal recess.[18,19,20]

Posterior Nares (Choana) : It is oval in shape and measures 2.5cm vertically and 1.5cm horizontally approximately.It has boundaries composed of bone and covered up by mucoperiosteum. The portion of the septum posteriorly is rarely involved in cases of congenital choanal atresia and post trumatic bony deviations which can cause posterior obstruction of the septum.[18,19,20]

FUNCTIONS OF THE NOSE:

It acts as a channel to the lower part of the respiratory tract, warms, humidifies and cleanses the inspired air as the turbulent flow passes over the membranous lining of the nasal passages. Its highly vascular supply allows the expansion and contraction of nasal according to the degree of vascular engorgement but any injury to the nasal airway can lead to profuse haemorrhage. Other functions are olfaction and phonation.[18,19,20]

THE PHARYNX

This musculofacial tube connecting the two cavities -nasal and oral to larynx and oesophagus. The buccopharyngeal fascia is the outer thin fascial layer of the pharyngeal tube which is thickened. Inferiorly it has continuity with the adventitia of the oesophagus and attaches to the skull bone superiorly.

Constrictor muscles: Three pharyngeal constrictor muscles forms the middle muscular layer. They are the superior , middle and inferior constrictor muscles.The superior constrictor has insertion to the base of the skull, to the hyoid bone and inferior to the cricoid cartilage. The inferior constrictor has a contribution to the band of muscle known as cricopharyngeus, which is the upper oesophageal sphincter. All the segments attaches behind the tendinous median raphe.[18,19,20]

DIVISIONS OF PHARYNX :

Pharynx has three divisions: the nasopharynx, the oropharynx and the hypopharynx. Because of its delicate muscular framework, it is more likely to sustain lacerations, retropharyngeal dissection and iatrogenic creation of false passages. Hence this knowledge is essential for anaesthesiologists before performing laryngoscopy for endotracheal intubation.

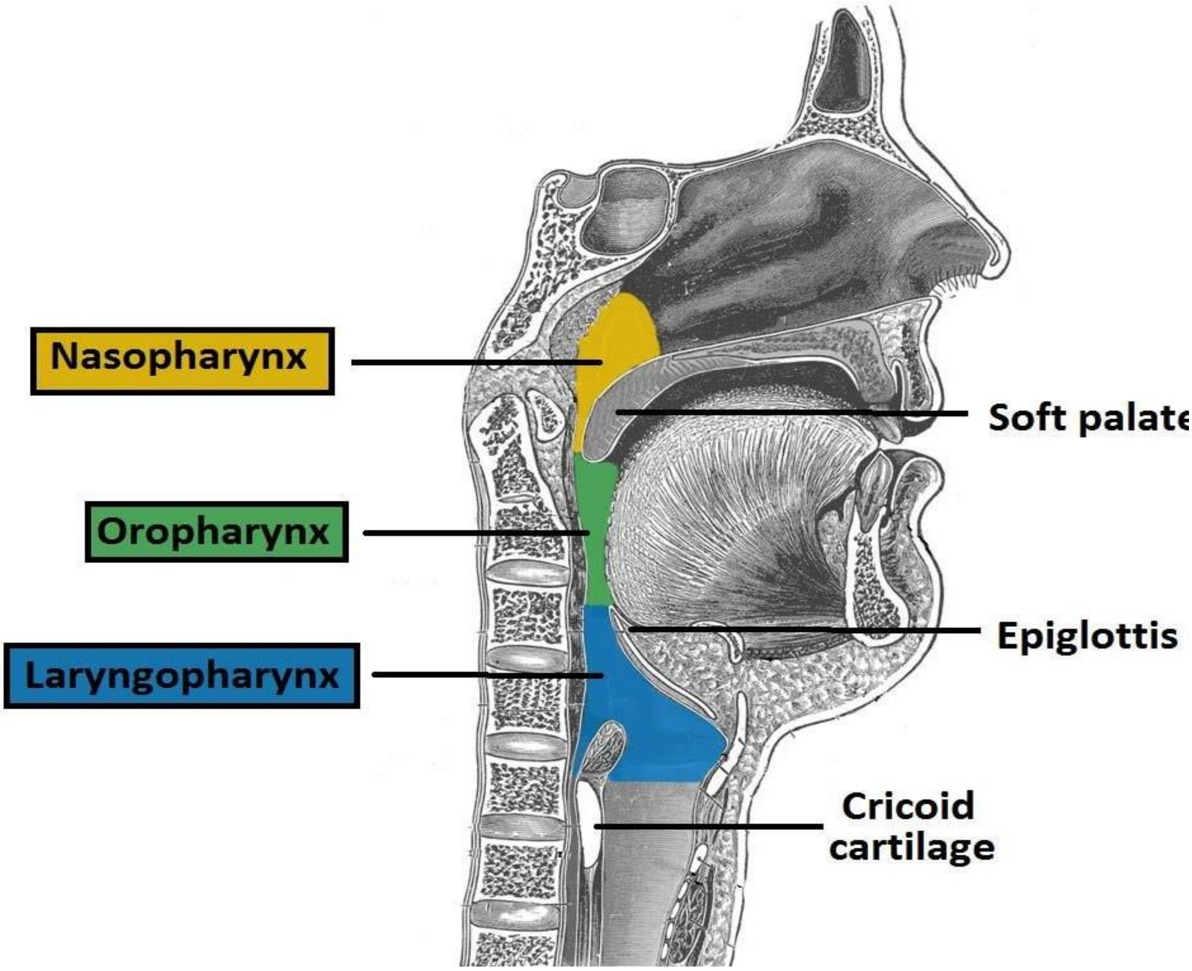


Figure 3: Section showing the subdivisions of the pharynx.

NASOPHARYNX:

Five openings into the nasopharynx - two nasal choanae, two orifices of Eustachian tubes and inferior passage to oropharynx. Its inferior border is at the soft palate level, the roof is composed by the sphenoid and the occipital bones of the skull base. Its continuous with the posterior nasopharyngeal wall. The posterior wall is separated from the spine by the prevertebral fascia, which contains the longus capitis muscle, the deep prevertebral musculature and the arch of the first cervical vertebrae.

Eustachian tube : It equalizes the middle ear and the atmospheric pressure when opened by the palatal muscles. The orifice of the tube is known as the torus tubarius located medially to the prominence of lateral cartilaginous. Fossa of rosenmullar is a recess above and behind the torus.Adenoid tonsil is the lymphoid tissue in the mucous membrane of the nasopharynx. Its hypertrophy can contribute to sleep apnoea and altered carbon dioxide levels.[18,19,20]

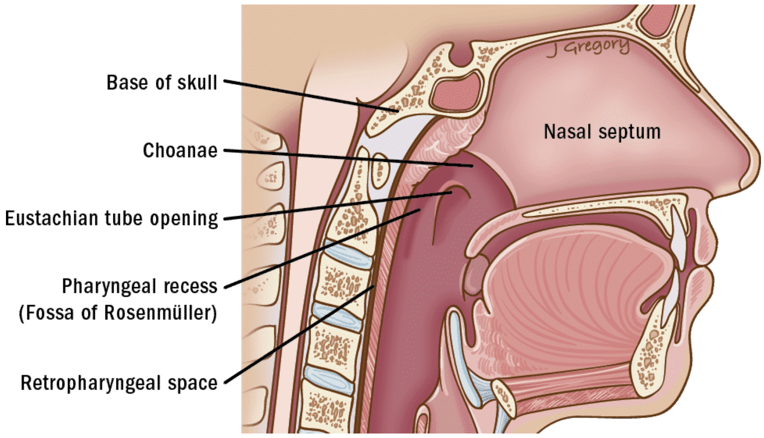


Figure 4 : Sagittal section showing parts of nasopharynx.

OROPHARYNX:

From soft palate superiorly it extends to the epiglottis inferiorly. Prevertebral fascia and bodies of the second and third cervical vertebra forms the posterior wall of the oropharynx. The lateral wall contains the paired tonsillar fossae. These contain the anterior pillars which are the palatoglossal folds and posterior pillars – the palatopharyngeal folds, contains the palatine tonsils.

The base of the tongue is situated medially to the tonsillar fauces. The base of tongue is attached by the paired lateral glossoepiglottic fold and single median glossoepiglotic fold to the epiglottis. The lingual tonsils is in the posterior dorsal tongue. Tongue musculature are of two types – muscles attached to styloglossus, genioglossus, hyoglossus and palatoglossus. Muscles such as transverse, superior and inferior longitudinal muscles and vertical muscles are present in the body of the tongue. The floor of the mouth is formed by the paired myohyoid muscles arising from the mandible and inserting in to the hyoid bone. Infections of the floor of the mouth such as the Ludwigs angina of the submandibular and submental spaces can produce airway obstruction. So tracheostomy can be done to secure the airway in such conditions.(18,19,20)

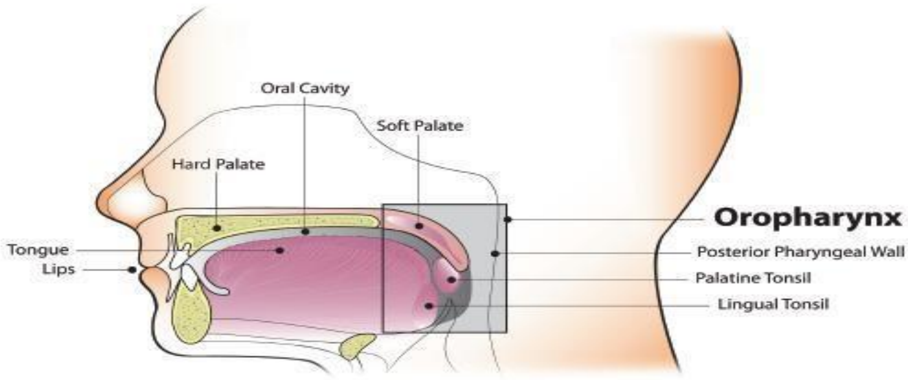


Figure 5 : Sagittal section showing various parts of oropharynx.

HYPOPHARYNX:

It is located at the level of the cervical vertebrae (C4-C6). It runs from the epiglottis inferiorly to the inferior surface of the cricoid cartilage. It opens with the oropharynx, laryngeal inlet, oesophagus. Either side of the hypopharynx is the pyriform fossa which is bounded superiorly by the lateral glossopharyngeal folds. The posterior border consists of prevertebral and bucco-pharyngeal fascia and deep prevertebral musculature..(18,19,20)

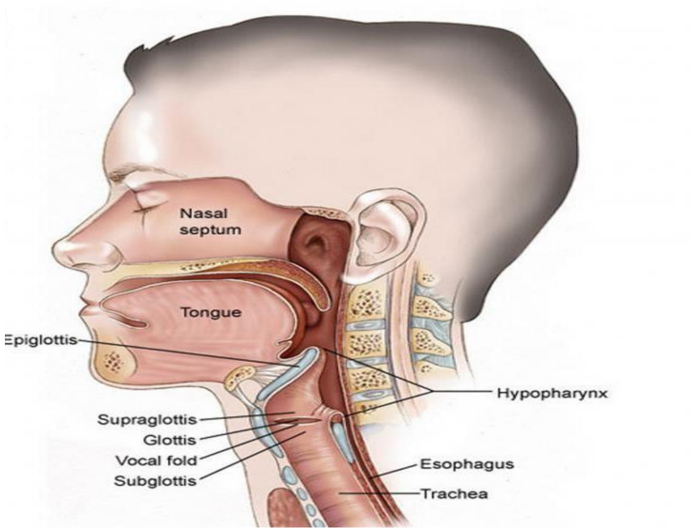


Figure 6: Sagittal section of hypopharynx.

LARYNX

Larynx acts as sphincter of protection by preventing aspiration during swallowing by separating the trachea and airway from upper gastrointestinal tract. It comprises of the vocal cords, which is vital for communication and also necessary for an coughing effectively.[18,19,20]

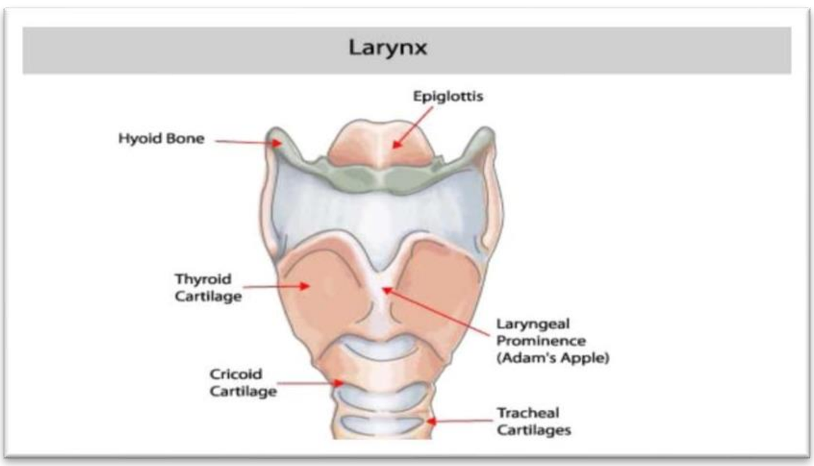


Figure 7: Anterior view of laryngeal cartilages

The location of the larynx is in the neck, situated anteriorly to the C4-C6 vertebral body and the laryngopharynx . Carotid sheath and one lobe of thyroid gland is on each side of the larynx. The thyroid gland has the isthmus anteriorly that lies on the tracheal rings.

Nine cartilages forms the skeleton of larynx, which are joined by numerous membranes and ligaments of which 3 are unpaired cartilages and 3 are paired cartilages.[21,22]

Thyrohyoid membrane attaches the hyoid bone (level with C3) to the thyroid cartilage. Beneath are the 3 cartilages which are unpaired :

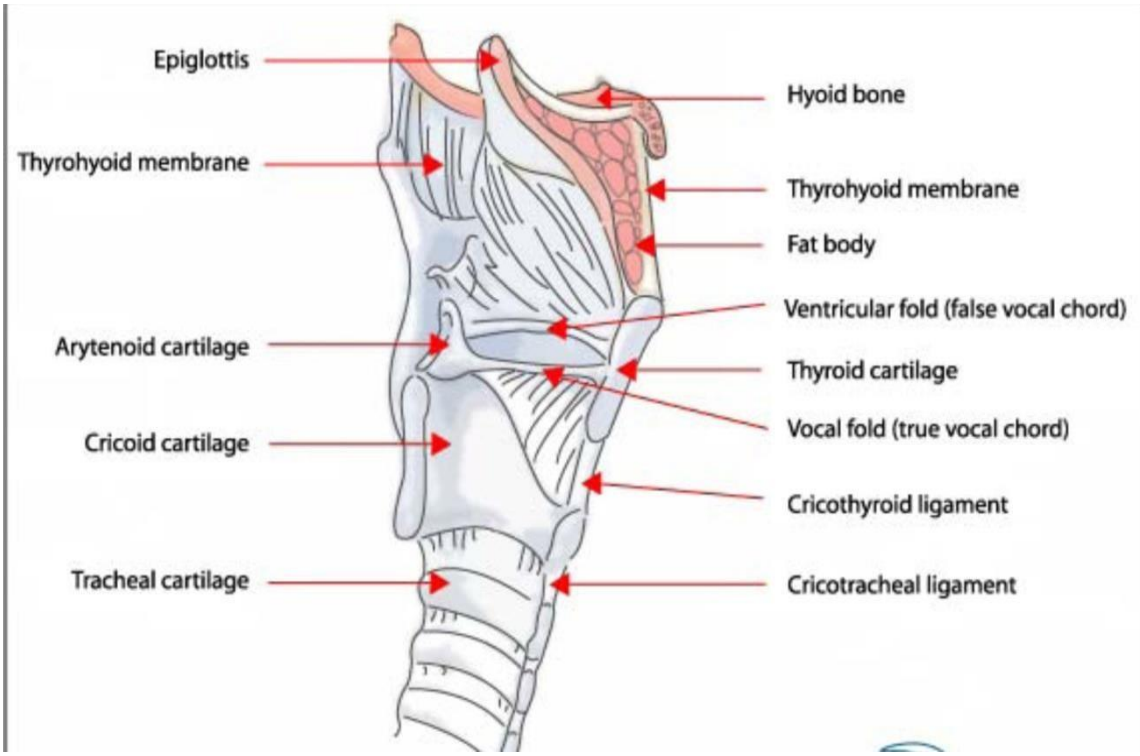


Figure 8: Lateral view of laryngeal cartilages

Thyroid cartilage. It is the one biggest among the cartilages of larynx and has a shape of a ‘shield’. It has 2 laminae fused at a 90° angle in men and at 120° angle in women in midline. It comprises of superior and inferior horns (cornua). The thyrohyoid membrane attaches to hyoid bone. The cricoid cartilage articulates with the inferior cornua.

Cricoid cartilage. It is the only complete ring of laryngeal cartilages and situated at C6 level. It communicates with the inferior horn of thyroid cartilage laterally, and with the arytenoid cartilages posteriorly. The cricotracheal ligament attaches it to the upper border of the tracheal ring. (Cricoid pressure, Sellick's manoeuvre). The cricothyroid ligament attaches it to the lower border of the thyroid cartilage. On application of pressure anteriorly to the cricoid it compresses the oesophagus lying posterior to it because it is a complete ring – a method for helping to prevent aspiration of gastric contents due to regurgitation in RSI (rapid sequence induction) of anaesthesia.

Epiglottis. It is a "leaf-shaped" elastic cartilage. The thyroepiglottic ligament attaches the lower end to the thyroid cartilage. It is anteriorly attached by the hyoepiglottic ligament to the hyoid bone. The superior border end is free to move upwards and the vallecula is situated in between the posterior part of the tongue with epiglottis.[21,22]

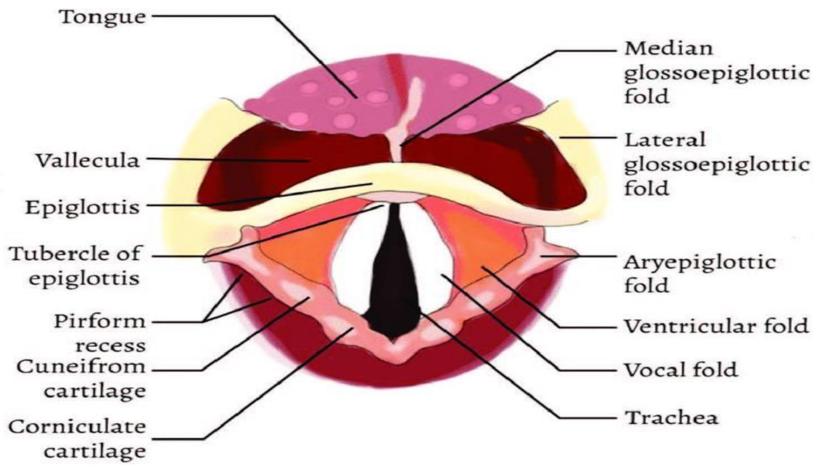


Figure 9: Showing the paired cartilages

Below are the three unpaired cartilages

Arytenoids. Cartilages which are paired with a shape of pyramid and communicates with the cricoid. Each has an apex to which the corniculate cartilages articulates, an anterior vocal process (posterior attachment of vocal ligament) and a lateral muscular process which articulates with the cricoarytenoid muscles. Being the posterior attachment to the vocal cords, they are the only structures seen in an airway which is assumed to be anterior.

Cuneiforms and corniculates - situated in the aryepiglottic folds. [21,22]

Ligaments and membranes

It connects the cartilages with each other and with the membrane that forms the vocal structures. The hyoid bone and thyroid cartilage are united by the thyrohyoid membrane. Cricothyroid membrane joins the cricoid and thyroid, and is where cricothyroidotomy is performed. The cricotracheal ligament binds the trachea's ring to the cartilage of cricoid.

Cricovocal membrane – the superior border of the cricoid connected to the thyroid cartilage prominence and the arytenoid. The uppermost border provides the framework for the true vocal cord and makes the vocal ligament.

Blood supply- larynx. Larynx is supplied by the superior laryngeal artery. It is formed by a the superior thyroid artery and the inferior laryngeal artery.

The innervation of the larynx

The vagus (X) nerve branches supply larynx:

Superior laryngeal nerve exits the tenth nerve in the neck and separates into internal branch is the sensory supply to the glottis, supraglottis and also to the cricothyroid muscle, which is the tensor of the vocal folds and receives its motor supply from the external branch. The recurrent laryngeal nerve provides sensory input to the subglottis and motor input to all intrinsic laryngeal muscles except the cricothyroid. The sensory supply to vallecula and the base of tongue is provided by glossopharyngeal nerve.[21,22]

THE APPLIED ANATOMY OF THE LARYNX

The nerves of larynx can be damaged in many ways such as in head and neck surgeries to lung and cardiac surgeries, cancers, trauma, airways and so on.

SLN may be damaged during thyroid surgeries, as it lies near the superior thyroid vessels. Cricothryoid function if lost can cause lack of vocal cord tension in unilateral damage and mostly compensated by the opposite cricothyroid.

RLN , may be injured during thyroid surgeries, as it lies near to the inferior thyroid vessels. Aortic aneurysm, enlarged right atrium, neoplasms of lung and esophagus, enlarged lymph nodes as it has longer course are some conditions damaging it.

In unilateral RLN damage, the vocal cords adopt a midline position, causing hoarseness to the voice, ineffective cough and can lead to aspiration recurrently. Whereas in scenarios of bilateral RLN injury, function of vocal cord may be completely lost causing airway obstruction.[20,21,22]

AIRWAY ASSESSMENT(23,24)(25,26)

History

- Past records of difficulty in airway management to predict challenging airway
- Old medical records to be reviewed for anaesthetic records like number of attempts to intubate, ability for mask ventilation, type of blades ,usage of adjunctive equipments, modification of techniques
- Diseases that affect the airways
- Symptoms of airway compromise such as dyspnoea, hoarseness, wheezing, stridor, dysphagia
- Associated diseases such as morbid obesity and physiological conditions such as pregnancy
- Prior surgery, burns, injuries, or malignancies affecting the mouth, neck, or spine
- Congenital syndromes, as well as infectious, neoplastic , traumatic or inflammatory conditions involving the airway

General examination

- Nares patency - masses like polyps, growths
- Teeth - Prominent upper incisors, canine
- Palate - High arched palate, long narrow mouth
- Prognathism - ability of protruding the lower jaw beyond upper incisors
- Temporomandibular joint - restriction of range of movement in fibrosis, tumors etc
- Mouth opening of at least 2 fingers breadths between upper and lower incisors
- Submental space - hyomental distance or thyromental distance >6cm

- Neck - Short, thick neck, masses in neck, extension and mobility of neck. Previous tracheostomy suggest stenosis
- Infections of airway - epiglottis, abscess, croup, bronchitis, pneumonia

Difficult mask ventilation BONES

- B - Bearded individual
- O - Obesity
- N - no or lack of teeth
- E - elderly
- S - snorers

Specific tests

For predicting difficulty in laryngoscopy and intubation. Two or more tests may improve the positive predictive value.

Direct assessment:

Assessing the flexion and extension of neck - To assess the flexion , ask the the patient to touch the manubrium sterni with his chin which ensures the neck flexion of 25 - 30 degree.

To assess the neck extension - Instruct the patient to look skyward without elevating their eyebrows, allowing neck extension for intubation.

Indirect assessment:

Palm print : In a sitting position, the patient is requested to push his right hand firmly against a white paper placed on a hard surface, with his palm and fingers smeared with blue ink.

Grade 0 - all pharyngeal regions are evident

Grade 1 - a deficit in the 4th and 5th digits' interphalangeal regions

Grade 2 - the interphalangeal portions of the 2nd and 5th digits are poor

Grade 3 - Only the tips of digits are visible

Prayer sign *:* The patient is asked to make “Namaste” by bringing both the palms together.

Positive : when there is gap between palms, which suggest limited cervical mobility leading difficulty in laryngoscopy and intubation.

Negative : when there is no gap.

Assessment of tempero - mandibular joint function :

Interincisor gap : Distance from the upper to the lower incisors. If the patient is able to occupy his three finger in the opening ,which is > 5 cm then it implies the adequacy for direct laryngoscopy and < 2 finger breadth that is < 3 cm is associated laryngoscopy.

TMJ movement : On asking the patient to open his/her mouth, the examiner places his index finger next to the tragus and his thumb in front of the bottom half of the mastoid process. If the index finger next to the tragus is depressed in its place and can feel the condyle slipping using the thumb, this indicates that the mandible has a good sliding function.

Protrusion of the mandible :

When patient protrudes the mandible, examiner should examine the lower teeth in relation to the upper teeth .

Class A : the lower incisor is protruded anteriorly beyond the upper incisors

Class B : the lower incisor is at same level as the upper incisors

Class C : lower incisor is not in edge to edge with upper incisor

Upper lip bite test :

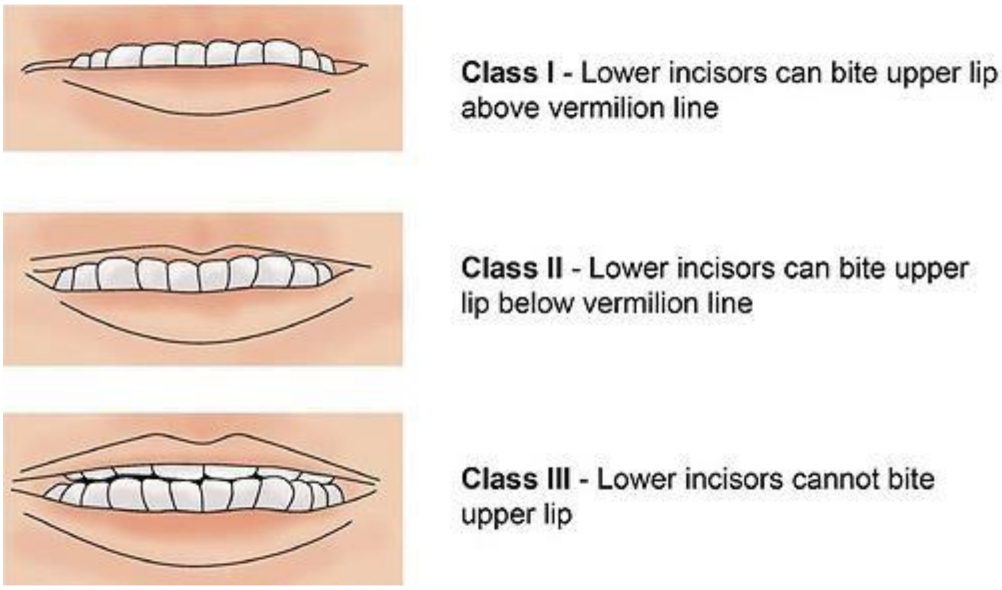


Figure 10: Upper lip bite test

Mallampati test :

It shows the correlation between the tongue and pharyngeal size. Examiner is seated facing the patient, where the patient should sit up with head in the neutral position and on asking should open their mouth maximally with protrusion of the tongue without phonation.

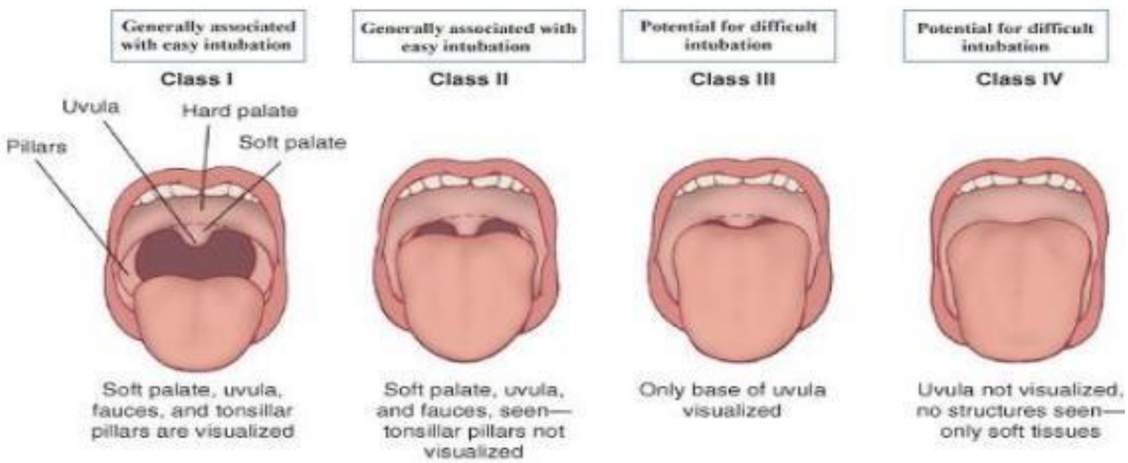


Figure 11: Modified Mallampati Classification

Assessment of mandibular space :

Thyromental distance(Patils test) :

When the neck of patient is fully extended, the space between the mentum and the thyroid notch is measured which measures the space in to which the tongue may be moved into during laryngoscopy. If greater than 6.5cm, it indicates easy laryngoscopy.

Sterno - mental distance : Distance between the suprasternal notch to the mentum with neck full extended and mouth closed. Normal is more than 12.5cm.

Hyo - mental distance : Distance between the mentum to hyoid bone. Normal is greater than 6cm.

Difficulty scores:

Wilson score :

Wilson risk sum score	0	1	2
Weight	<90 kg	90-110 kg	>110 kg
Head & neck movement	>90 degrees	About 90 degrees (i.e. +/- 10 degrees)	<90 degrees
Jaw movement	IIG >5 cm or Slux >0	IIG <5 cm and Slux =0	IIG <5 cm and Slux <0
Receding mandible	Normal	Moderate	Severe
Buck teeth	Absent	Moderate	Severe

Figure 12: Wilson score for airway assessment

These factors are given scores between 0 to 10, the greater the score, greater the risk for difficult intubation.

LEMON / MELON : A score of up to ten points is derived by awarding one point to each of the following factors. Patient in difficult intubation has high lemon scores.

LEMON Airway assessment method

L	Look externally (Facial trauma, large incisors, beard or moustache, large tongue
E	Evaluate the 3-3-2 rule - Incisor distance: 3 FB - Hyoid-mental distance: 3 FB - Thyroid-to-mouth distance: 2 FB
M	Mallampati Score ≥ 3
O	Obstruction : Presence of any condition like epiglotitis, Peritonsillar abscess, trauma
N	Neck Mobility (Limited neck mobility)

Figure 13: LEMON airway assessment

Rapid assessment of the airway by 1-2-3 rule : determining factors for the ease of glottis visualisation in an emergency

- Mobility of TM joint
- Mouth opening
- Thyromental distance
- **Cormack and Lehane Classification:** It is divided into four grades according to degree of glottic exposure.

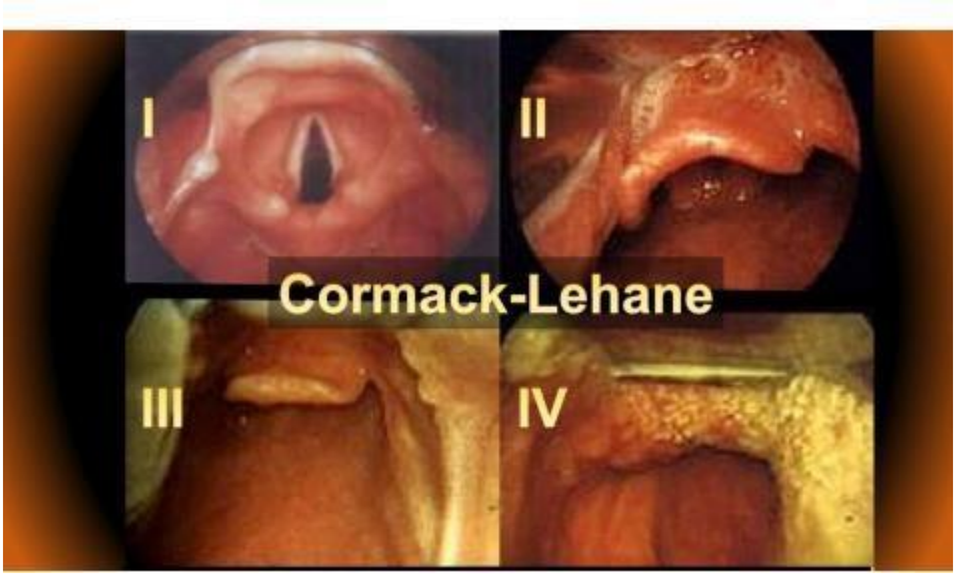


Figure 14: Laryngoscopic view of glottis-Cormack Lehane Grade

LARYNGOSCOPES

The larynx is viewed with laryngoscope, which is mostly usually used to introduce the tube into the tracheal tree. Other applications are placing a feeding tube or transoesophageal echo cardiac probe, removal of foreign body, and evaluating the upper airway. They are of various types ranging from simple rigid scopes to complex fiberoptic video devices.[27,28]

Rigid Laryngoscope

Rigid laryngoscopes are mostly of two types - as a single-piece or a separate detachable blade and handle. In the detachable type, the light source is either a lamp fitted to the blade or a light indicator in the blade with a bulb in the handle. The most typical connection between the handle and blade is a hook-on attachment which turns on the light source on being locked into position. A hinge pin placed in a groove on the blade's base connects the handle to the blade. It helps to connect and disengage the blade easier. A switch on the handle in single piece laryngoscope controls power to the lamp.

Handle

It's the part of the laryngoscope that you hold in your hand, and generates the light. The handle has a rough surface to improve the grip. Most commonly, power source for the light are the disposable batteries. The metallic contact in the handle attaching to the blade having a light bulb, completes an electrical circuit when they are in the operating position. Some handles have the bulb and battery portion to be removed as a unit which allows the outer part of the handle to be cleaned and sterilized.

Handles are available in different sizes. Short handles are recommended for patients whose chest and/or breasts come into touch with the handle, when cricoid pressure is applied, or when the subject is in a body cast. Most blades forms right angle with handle but the angle may also be acute or obtuse. An adapter that can be inserted between the handle and the blade can change the angle.

Figure 15: Laryngoscope handle

Blade

This is the section that goes into the mouth. Because blades come in a variety of sizes, they are numbered, with the number increasing as the size decreases. The section of the blade that attaches to the handle is called the base. It has a groove where the handle's hinge pin is mounted. The base comes to a stop at the heel. The tongue, which pressures and manipulates the soft tissues is the major shaft. The blade can be curved or straight, depending on the form of the tongue. Better laryngeal visualization is seen with straight blade, while curved blades make intubation easier.

Figure 16 : Laryngoscopy Blade

The flange, which protrudes from the side of the tongue, guides equipment and diverts tissues out from the line of vision. The blade's cross-sectional form is regulated by the flange. The step is a term used to describe the vertical height of a blade's cross-sectional form. The epiglottis is directly or indirectly elevated by the tip of the blade, so to decrease the trauma the tip is blunted or thickened. The blade has a bulbs which screws into a socket located near the tip that has a metallic contact.[27,28]

Curved Blade Technique

Following epiglottis imaging, the blade is progressed until the tip fits into the vallecula, and traction is used all along handle at right angles to the blade, moving the base of the tongue and epiglottis forth and revealing the glottis. Pulling the handle backwards may force the tip to push the larynx upward and out of sight, as well as potentially damaging the teeth and gums.

Sometimes the larynx may not be visualized with a correct technique. Outward backward, upward, and rightward pressure (BURP) on the thyroid cartilage causes the larynx to be pushed and mandibular advancement may improve visualization of the glottis. [27,28]

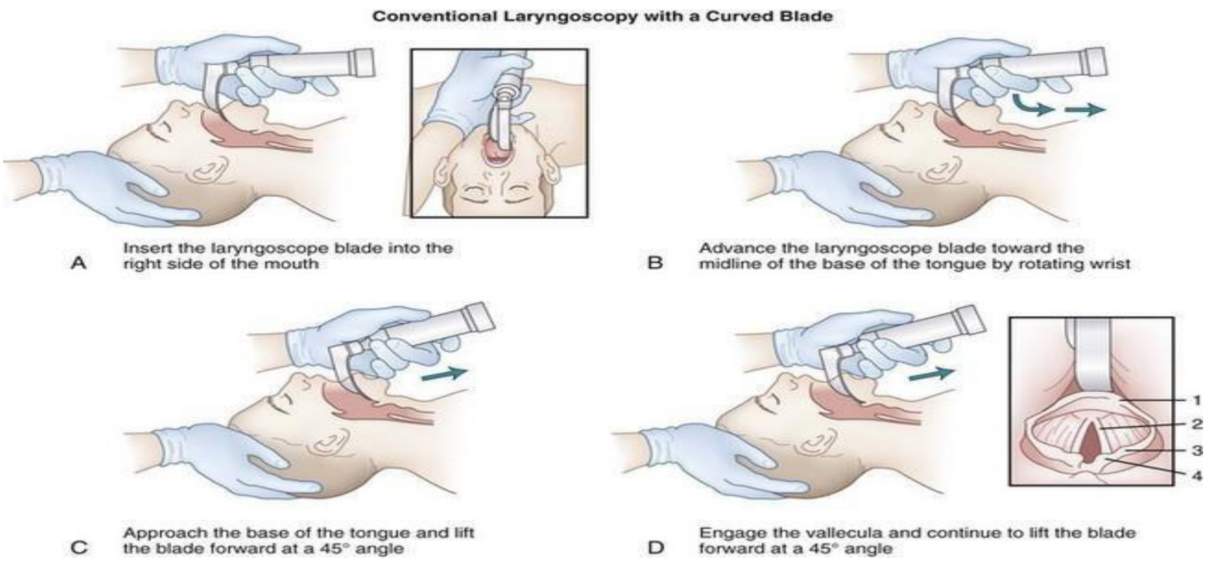


Figure 17 : Conventional Laryngoscopy with Curved blade

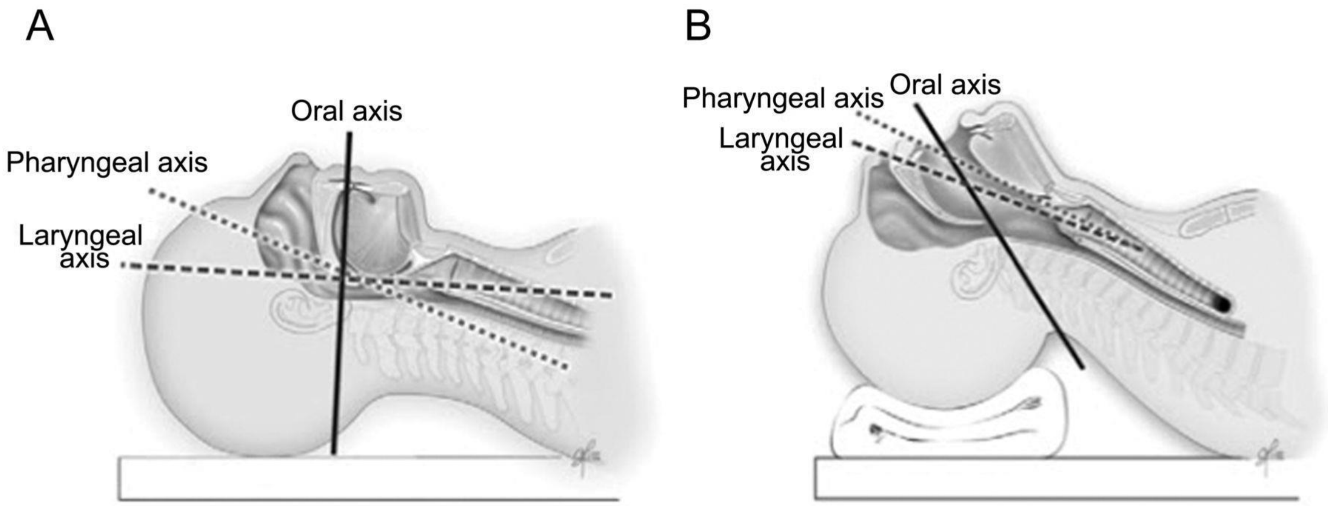


Figure 18 : Sniffing position

The 3-axes synchronisation hypothesis and the classic sniffing position or ideal head position for direct laryngoscopy. The oral axis is a horizontal line that runs throughout the front of the tongue. The pharyngeal axis is a tangential line that runs from the uvula to the epiglottis' inferior aspect. A: A line formed at a right angle to the voice cords is known as the laryngeal axis. B: The oral axis is more strongly connected with these two axes when the head is extended at the atlanto-occipital joint.

ULTRASONOGRAPHY[29,30]

Above 20 kHz are the mechanical waves known as “ultrasound and is made by small piezo crystals. Frequency of transducer used depends on thickness of the piezoelectric ceramic plates. The ultrasonographic images are computerised images of the reflected waves.

A linear (5 - 13 MHz) transducer is employed for visualising the superficial anatomical structures like the cricoid cartilage, epiglottis, or trachea. Locating the deeper anatomical structures, ultrasound probes having frequency of 4 - 11 MHz are most commonly used. If the frequency is lower, the higher will be the tissues penetration but lower will be the image clarity. Hence the higher frequency probe gives better clarity but lack of depth is seen, whereas low frequency probe has a superior evaluation of depth with poor resolution. As sound passes through soft tissue structures refraction, absorption, reflection, scatter and transmission of sound occur, which helps formation of the imaging of that structure.

Echo which returns after striking a tissue is defined by a characteristic known as acoustic impedance. There is an acoustic impedance mismatch and hence shows as bright white image. Structure which are mostly cartilaginous are homogeneously hypoechoic. Bone appears to be a bright structure and is said to be “hyperechoic.”

On examination with ultrasound fluid has an anechoic appearance. The lowest acoustic impedance is possessed by air. Therefore the air present intraluminally can cause both comet tail as well as artefacts. Hence, it is an issue when attempting to image air-filled structures like trachea. Nerves can be seen having “honeycomb”,“pepper pot” hypoechoic structure against a hyperechoic background. Glands like the submandibular and thyroid are strong to mild hyperechoic when compared to the surrounding soft tissues.

Figure 19: Ultrasound machine with curvilinear and linear probes

Airway ultrasonography can be practiced using two approaches.

Transcutaneous approach

Upper airway examination from oral cavity to the tracheal and paratracheal areas using linear or curvilinear transducer placed in parasagittal, sagittal, oblique and transverse planes.

Transoral approach

The probe to tissue contact is good without eliciting gag reflex hence forming images which are clear. There is difficulty in this approach to become popular with anaesthesiologists due to the discomfort of probe beneath tongue, difficulty of performing in uncooperative patients and steeper learning curve.

Sonographic Appearance of Various Airway Structures

Examination of airway done with the patient in supine position and neck maybe extended or in neutral position.

Tongue when visualised with a low-frequency curvilinear probe has a hyperechoic appearance. Apposition of tongue facilitates imaging of the anterior portion of the tongue. Fan shaped appearance of the tongue is used for determining the cross-sectional area. The floor of the mouth and tongue viewed well in the axial section.

Epiglottis is the hypoechoic structure seen as an inverted C structure in transverse view. The pre-epiglottic space lies anteriorly to the epiglottis which is hyperechoic because of the presence of fat. An inverted U shaped structure which is hyperechoic in the submandibular region is the hyoid bone.

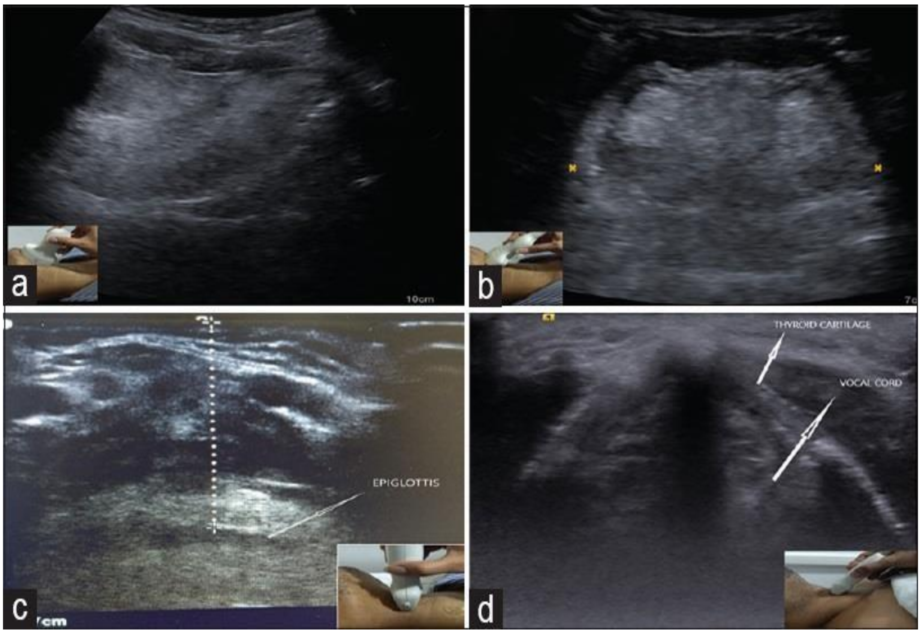


Figure 20 :(a)Longitudinal view of Tongue . (b)Axial view of mouth and tongue (c)Axial section of epiglottis (d) Vocal cords

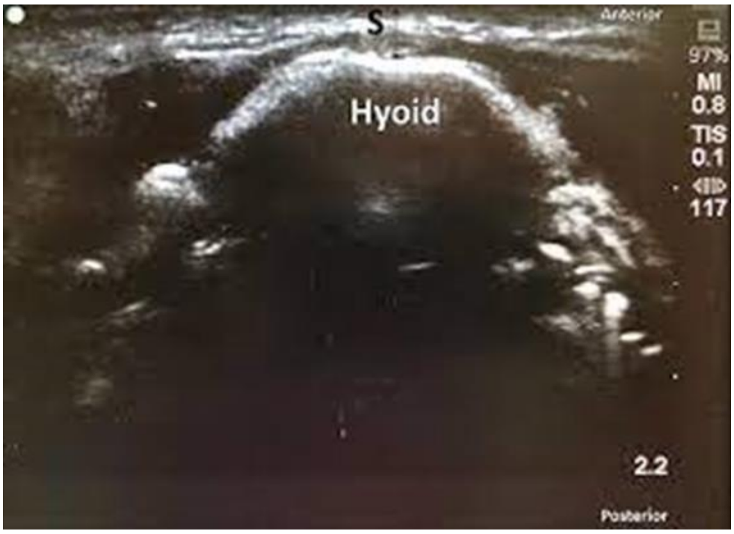


Figure 21: Ultrasonographic image of hyoid bone

Air filled trachea and larynx are ideal for ultrasound image visualisation. The intrinsic muscles of the larynx are less echogenic than cartilages such as thyroid, cricoid and arytenoid. Tracheal rings seen as hypoechoic structures with ultrasonography. Tracheal rings have an inverted U-shaped hypoechoic appearance on transverse view and in parasagittal view, it has a “string of beads” appearance.

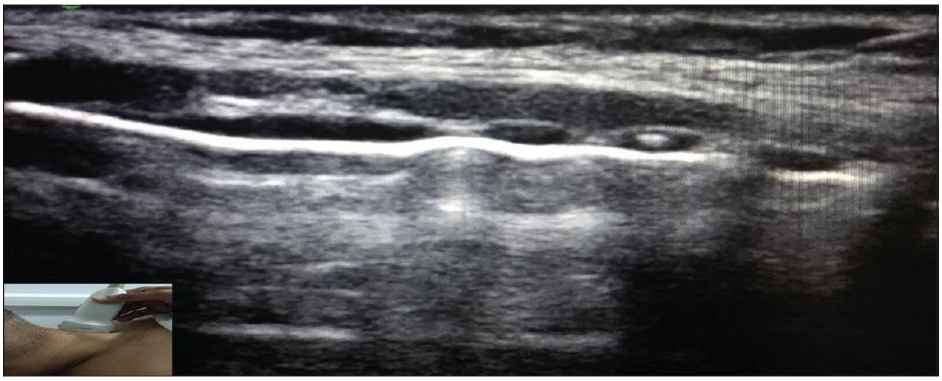


Figure 22 : Tracheal rings appear as “String of beads”

Applications

Difficult airway prediction

Using ultrasonography, tongue and anterior soft tissue thickness at hyoid bone level and thyrohyoid membrane are measured and found these parameters to be good predictors in identifying difficult and easy intubation. Difficult laryngoscopy was seen in cases with more thickness of soft tissue of neck anteriorly.

Cricothyroid membrane identification

Identification of cricothyroid membrane helps to find accurate tracheal space avoiding vessels, and also guides the depth from skin, commonly in obese patients. It is also helpful in scenario of difficult airway, retrograde intubation, cricothyroidotomy and percutaneous tracheotomy.

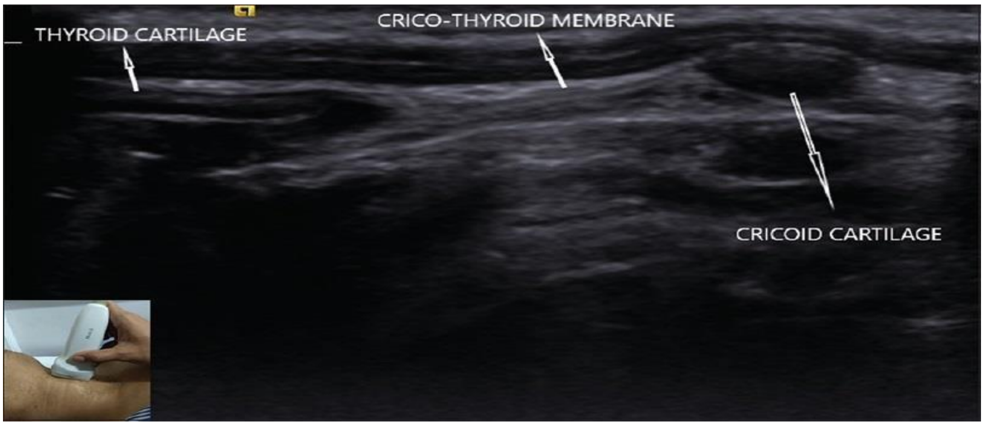


Figure 23: Cricothyroid membrane (sagittal plane)

Endotracheal tube size prediction

Subglottic airway ultrasonography which proven better than conventional formulae is used for predicting appropriate ETT size and thereby preventing repeated intubation attempts especially in the paediatric population. This is very important in cases where an inappropriate tube size may cause oedema of airway to airway leakage.

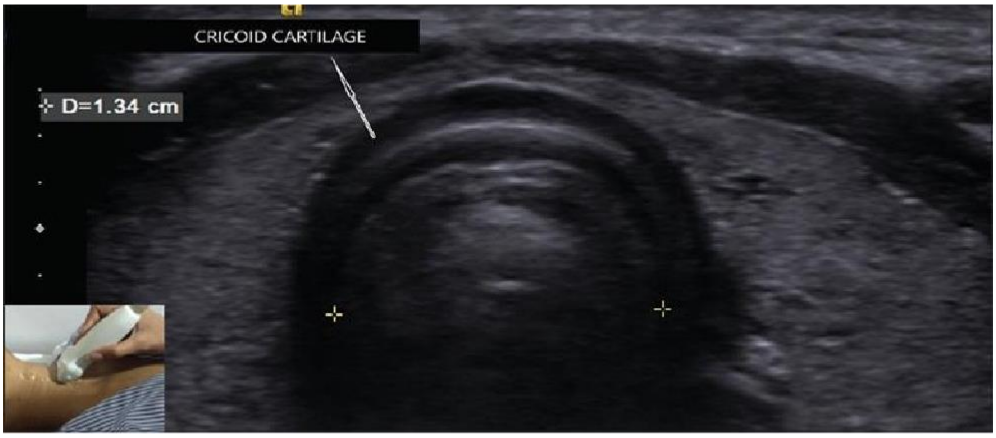


Figure 24 : Determining size of endotracheal tube by measuring subglottic diameter (air column measurement)

Double lumen tube size determination

Just above the sternoclavicular joint, the outer width of trachea is measured and is used for finding out the appropriate double lumen tube size.

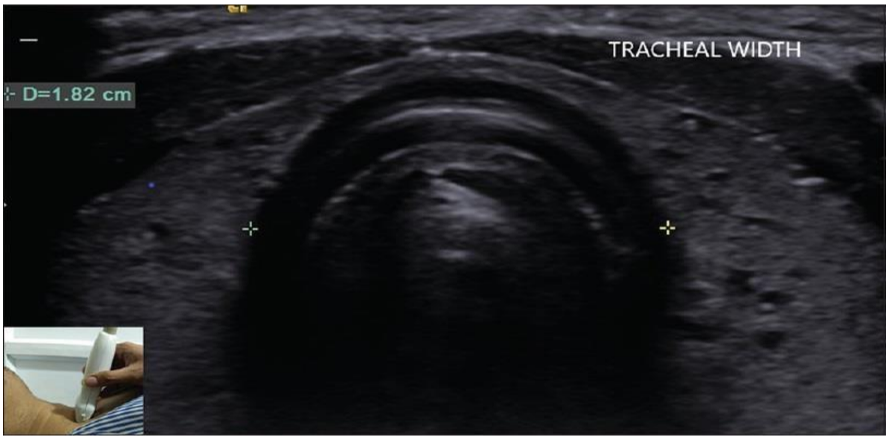


Figure 25: Measurement of tracheal diameter (axial view)

Confirming position of endotracheal tube

Capnography though is the gold standard for confirming the location of the endotracheal tube, there are certain situations where other methods for the endotracheal position confirmation has to be employed. Capnography may not be useful in patients with pulmonary embolism or cardiopulmonary arrest hence the need for an alternate, convenient method such as ultrasound. Oesophageal intubation is seen to have a "double tract" appearance on ultrasound evaluation.

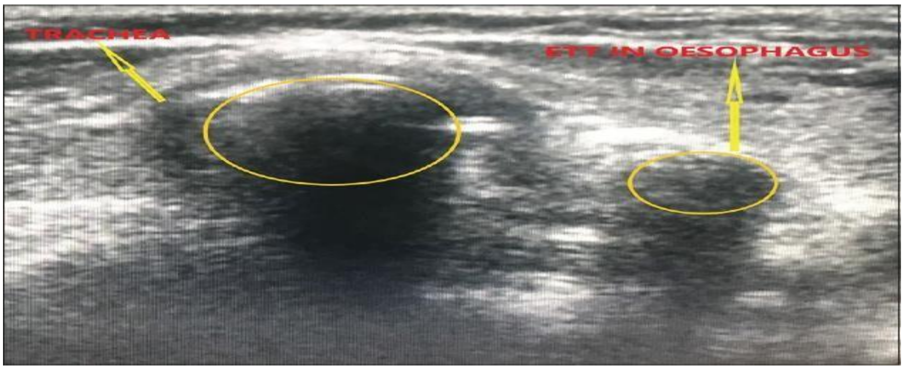


Figure 26 : "Double tract" sign of oesophageal intubation

Correct ETT depth confirmation

In paediatric and pregnant patients ultrasonography is very helpful. Mid - sagittally on the sternum the probe is placed for paediatric patients, and tip of endotracheal tube confirmed when seen above aortic arch or carina.

Endobronchial intubation detection

The movement of the diaphragm and lung-sliding sign presence on the lung indicates ventilated lung and if there is absence or restriction of diaphragmatic movement and negative lung-sliding sign in the other lung (nonventilated) endobronchial intubation can be diagnosed.

Percutaneous dilatational tracheostomy facilitated

Ultrasound helps to perform this procedure safely. From appropriate area of insertion, determining size of tracheostomy tube, avoidance of bleeders and formation of "false passages," and also confirmation of procedure can be done safely with ultrasound. This helps in cases of altered airway anatomy due to head and neck cancers.

Position of laryngeal mask airway detection

Ventilation using supraglottic airway device under general anaesthesia needs correct placing of it as well as a tight sealing of the glottic opening. Due to occurrence of incorrect placement of LMA, prompt identification and proper placement is necessary for ventilating adequately. Fibreoptic bronchoscopy has been used for optimal LMA placement identification but confirmation of supraglottic airway device placement requires discontinuation of ventilation. Other tests have certain drawbacks.

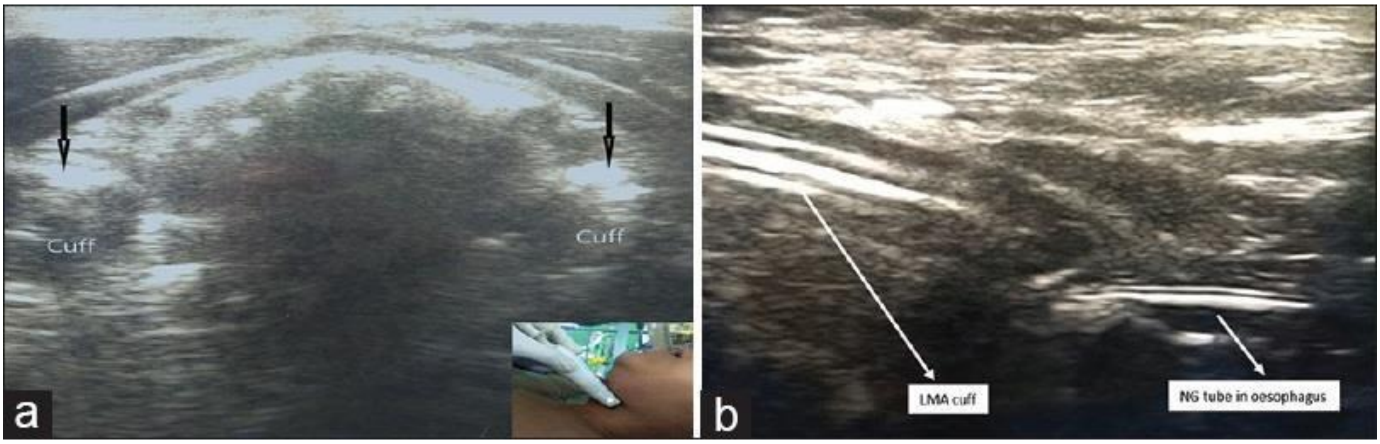


Figure 27 : a)Visualisation of LMA cuffs(transverse plane). (b)Ryles tube seen(parasagittal view)

Predicting post-extubation stridor

Oedema of larynx and ulcerations of mucosa are commonly seen in patients who are intubated for more than 24 hours in cases of trauma and in ICU settings. This can cause post extubation stridor.

Vocal cord assessment / recurrent laryngeal nerve (RLN) palsy detection

Useful in determining preoperative RLN involvement in cancer of head and neck especially in thyroid cancers . This non - invasive assessment has a good association with findings of flexible fiberoptic bronchoscopy. It also is utilised to ensure that recurrent laryngeal nerve is not injured intraoperatively by ultrasonographic evaluation of vocal cords after the thyroid surgery.

Stenosis of trachea detected

Caused by multiple reasons but mainly seen post intubation and infection, trauma, oedema and so on. Trachea can be scanned for any irregularities in its shape or decrease in diameter.

Tracheal wall thickening determination

Tracheal wall thickness normally has a measurement of approximately 1.4 mm in males and 1.3mm in females. Thickness of tracheal wall is increased in cases of sarcoidosis, infectious pathologies and oedema of trachea. Due to smoke inhalation if airway is involved it can be detected with this technique.

Intrathoracic extent of goitre identification

A noninvasive, bedside method to diagnose the goitre extension in the thoracic cavity is by utilisation of ultrasonography. Mediastinal mass appears as a continuum of thyroid.

Epiglottitis diagnosis

Epiglottitis is an emergency requiring immediate treatment and careful monitoring of airway. Ultrasonography helps in fast recognition in an urgent scenario. "P-sign" appearance is seen in sagittal neck view. It causes increase in diameter of epiglottis as observed in transverse view. It has a significant role in patients developing swollen epiglottis after radiotherapy mainly to head and neck, and for predicting difficulty of the airway.

Obstructive sleep apnoea diagnosis

Polysomnography is thought to be gold standard in diagnosing obstructive sleep apnoea but the main limitation is that it is costly and takes a lot of time to perform. Scanning modalities such as CT scans and MRI causes radiation being exposed to the patient in addition to being expensive. Ultrasound is inexpensive and noninvasive. Ultrasonography in the submental view is utilised for the diagnosis of obstructive sleep apnoea.

Risk of aspiration assessment

Ultrasonography can also be utilised for assessment of the type and amount of gastric contents. Supine and lateral position (right) are given to the patient on examination .

The area being evaluated is stomach antrum that appears as "bull's eye" when void, "starry night" with air within the fluid, hypoechoic or anechoic when filled with clear fluid and hyper-echogenicity appears as "frosted glass" when with solid particles. Patients who are having emergency procedures and where history of food intake cannot be received (e.g. cognition dysfunction, traumatically injured victims). Gastric amount of liquids if more than 1.6 ml/kg indicates there is lack of adequate fasting and hence risk for aspiration higher. The drawback of assessment are that it can be applied for clear fluids and validated in subjects with BMI less than 40 kg/m^2.

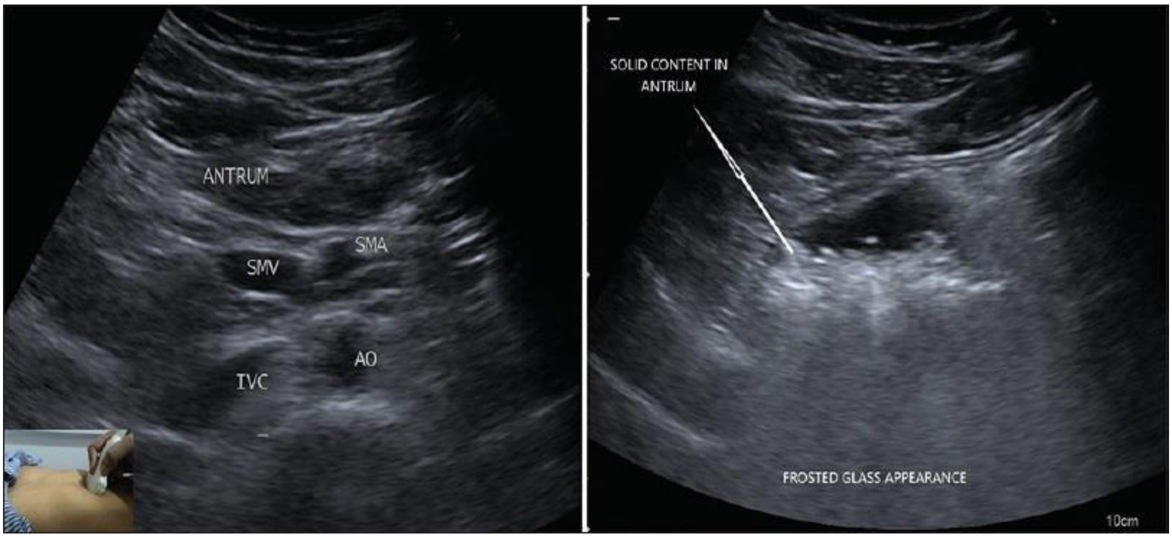


Figure 28: Ultrasound to assess gastric content volume

Limitations of Using Ultrasound

The person performing the ultrasonographic evaluation should have good ultrasonographic anatomy knowledge to differentiate artifacts from the object studied. Image formed depends on the operator and used machine. It has a steep learning curve as it needs practice and time to be skilled in the art of ultrasonography.

MATERIALS AND METHODS

SOURCE OF DATA

This study was conducted in the Department of Anaesthesiology, Shri. B. M. Patil Medical College, Hospital and Research centre, BLDE Deemed to be University, Vijayapura.

METHOD OF COLLECTION OF DATA:

Study Design: A prospective observational study

Study method: The study population of 72 with age, weight and sex matched following which Modified Mallampatti score and Thyromental distance were measured and ultrasonographic measurements of distance from skin to epiglottis (DSE) and skin to hyoid bone (DSHB) were taken.

Study Period : From January 2021 to August 2022

Sample size

The anticipated Mean±SD of the thickness of the ultrasound measured the distance from the skin to epiglottis 2 ± 0.3 (ref) the required minimum sample size is 72, to achieve a power of 95% and a level of significance of 1%. In the study by Abdelhady et al[3] used as reference the minimum sample size was 80 group with 95% power.

$$N = 2\left[\frac{(Za + Z\beta) * S}{d}\right]^2$$

Za - Level of significance=95%

$Z\beta$ -the power of the study=90%

SD= Common standard deviation

Statistical method:

The data obtained was entered in a Microsoft Excel sheet, and statistical analysis performed using a statistical package for the social sciences (Version 20).

• Results were presented as Mean ±SD, counts and percentages, and diagrams.

• For normally distributed continuous variables between two groups were compared using Independent t-test. Categorical variables between the groups was compared using the Chi-square test.

• Logistic regression was performed to test the association between the variables.

P <0.05 was considered statistically significant. All statistical tests were performed two-tailed.

Randomization: The study population was assigned using a computerized random number table.

Results were recorded using a preset proforma of the study

STUDY POPULATION

This study was done in adult patients aged between 18-60 years undergoing various elective surgical procedures under general anaesthesia.

INCLUSION CRITERIA

- ASA grade I and II patients requiring endotracheal intubation for surgeries under general anaesthesia
- Age between 18 and 60 years
- Both male and female patients

EXCLUSION CRITERIA

- Patient refusal or inability to consent
- Patients with pre-existing airway malformation or pathologies like facial or cervical fractures, maxillofacial abnormalities, cervical tumours, or goitre
- History of difficult laryngoscopy
- Body mass index > 40kg/m^2
- Patients undergoing rapid sequence intubation
- Pregnant patients

METHODOLOGY

Preanaesthetic evaluation:

Preanaesthetic evaluation included the following:

History:

History of underlying medical illness, previous history of surgery, anaesthetic exposure and hospitalization were elicited

Physical examination

General condition of patient

Vital signs - heart rate, blood pressure, respiratory rate

Height and weight

Examination of respiratory system, cardio vascular system, central nervous system and the vertebral system.

Procedure was explained to the patient

INVESTIGATIONS /INTERVENSIONS

Routine investigations were required in this study like: CBC, BT, CT, HIV, HbsAg, Urine routine, Random blood sugar, Blood Urea, Serum Creatinine, chest radiograph and ECG.

Procedure:

- Preanaesthetic checkup was done in the ward.
- Patients were kept nil by mouth 6 hours before surgery.

- Patients were selected for the study based on inclusion and exclusion criteria.
- Procedure was explained to the patients and informed consent taken
- After shifting the patient to the preoperative room Modified Mallampatti score and thyromental distance measured and ultrasonographic measurements between the distance between skin to epiglottis (DSE) and distance from skin to the hyoid bone (DSHB) were taken using ultrasound.
- In the total 72 patients assessed, Modified Mallampatti grading and thyromental distance were measured. Modified Mallampatti grades 1 and 2 were considered to be easy laryngoscopy whereas grades 3 and 4 were considered to be difficult laryngoscopy. Thyromental distance of less than 6.5 cm was predicted to have difficult laryngoscopy and more than 6.5 cm was predicted to be easy laryngoscopy.
- The 72 patients also underwent airway assessment using the ultrasound. The patient was positioned supine with the head and neck in a neutral position and ultrasound measurements were taken by the primary investigator with the help from an experienced anaesthesiologist trained in ultrasonography. Ultrasound probe was positioned transversely at the thyrohyoid membrane level. Patients were told to breathe slowly during assessments to reduce errors during respiration.
- The epiglottis was identified as a curvilinear hypoechoic structure at the thyrohyoid membrane level with a air mucosal interface seen posteriorly .
- Distance between skin surface to the middle axis of the highest part of the epiglottis in centimeters measured through the thyrohyoid membrane with varying degrees of cephalad or caudal angulation using USG linear probe (Sonosite M-Turbo machine) on B mode.

- Ultrasonographic measurement of distance from skin to epiglottis if more than 1.85 cm was considered to have difficult laryngoscopy and value if less than 1.85 cm was supposed to be easy laryngoscopy

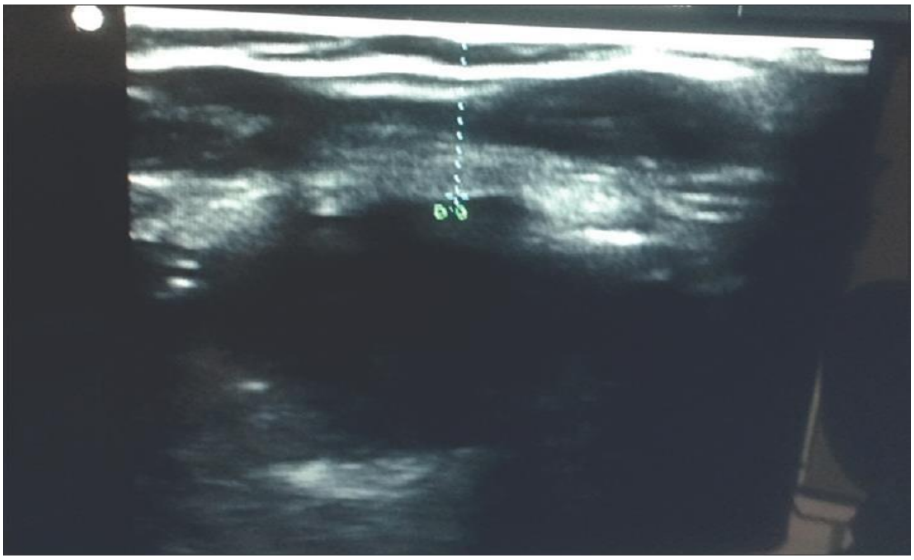


Figure 29: Distance from skin to epiglottis seen

- The hyoid bone was identified as an inverted U shaped hyperechoic structure in the submandibular region. The measurement from the skin to the midpoint of the hyoid bone was taken. The distance from skin to hyoid bone measurement using ultrasound if more than 0.78 cm was considered to have difficult laryngoscopy and if measurement was less than 0.78 cm was considered to be easy laryngoscopy.

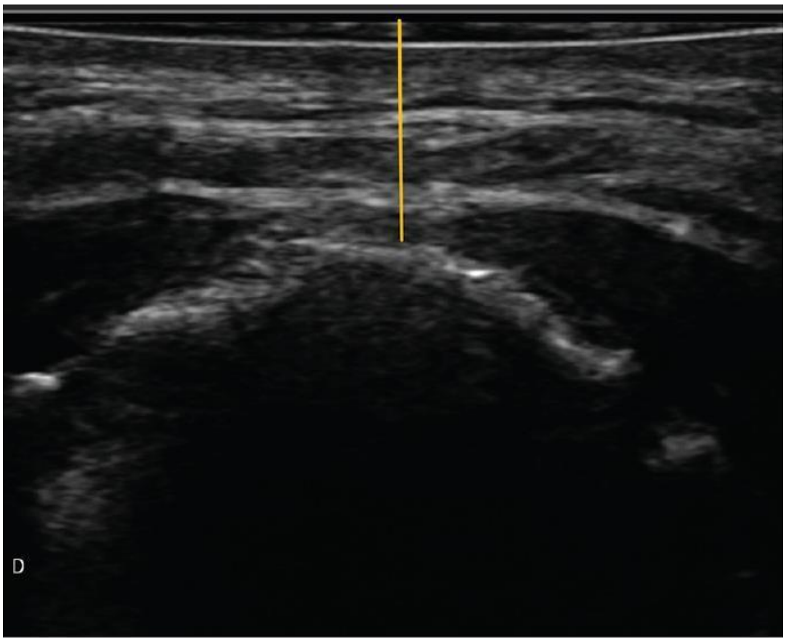


Figure 30: Distance from skin to hyoid bone measured with ultrasound

- Patients were then taken to the operation theatre, standard monitoring devices including a pulse oximeter, sphygmomanometer cuff, $ETCO_2$, ECG leads connected, and baseline values were recorded.
- IV line secured with 22G cannula, and the patient premedicated with Inj Ondenstron 0.15 mg/kg IV, Inj glycopyrolate 0.01 mg/kg IV and Inj Midazolam 0.1 mg/kg IV. Preoxygenation done with 100% oxygen was done for 3 minutes.
- General anaesthesia induced with propofol (2mg/kg) and muscle relaxation achieved by Inj atracurium 0.5 mg/kg to facilitate the endotracheal intubation by direct laryngoscopy.
- The tracheal intubation was done with an appropriately sized ETT (endotracheal tube) by an anaesthesiologist who was blinded to the study. Laryngoscopy was performed with Macintosh blade, and then the Cormack Lehane (CL) grade noted without external manipulation of larynx. Based on Cormack Lehane grading patients were then categorised into easy or difficult laryngoscopy groups. Patients with CL grades 3 and 4

were classified as difficult laryngoscopy group, whereas CL grades 1 and 2 were classified into easy laryngoscopy group.

- Patients were maintained under anaesthesia using oxygen, air and isoflurane and atracurium.
- Patients were reversed with 0.05 mg/kg of neostigmine with 0.01 mg/kg of glycopyrolate, in the end after surgery carried out, at the first attempts of breathing. They were extubated when fully awake and adequately reversed
- They were monitored for half an hour postoperatively before being shifted to the ward for further management.

STATISTICAL ANALYSIS

Data was represented using Mean ±SD, percentages and diagrams. For continuous variables, the summary statistics of mean± standard deviation (SD) were used. Basic variables such as age and BMI were represented using Mean ±SD and comparison between the variables was done using Mann Whitney U test. Categorical variables between the groups was compared using the Chi-square test.

For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation.

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data was analysed using SPSS software.

OBSERVATION AND RESULTS

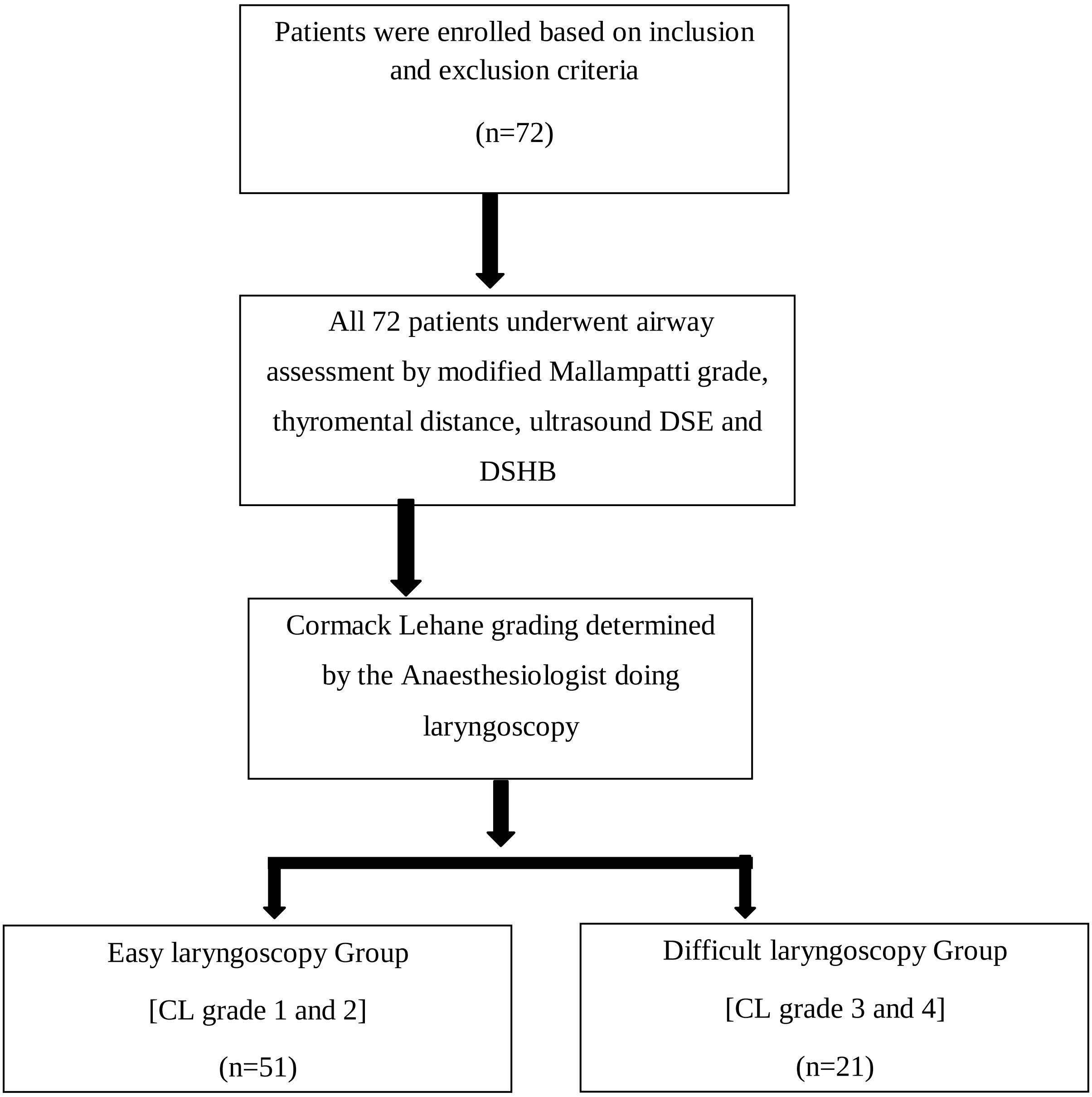


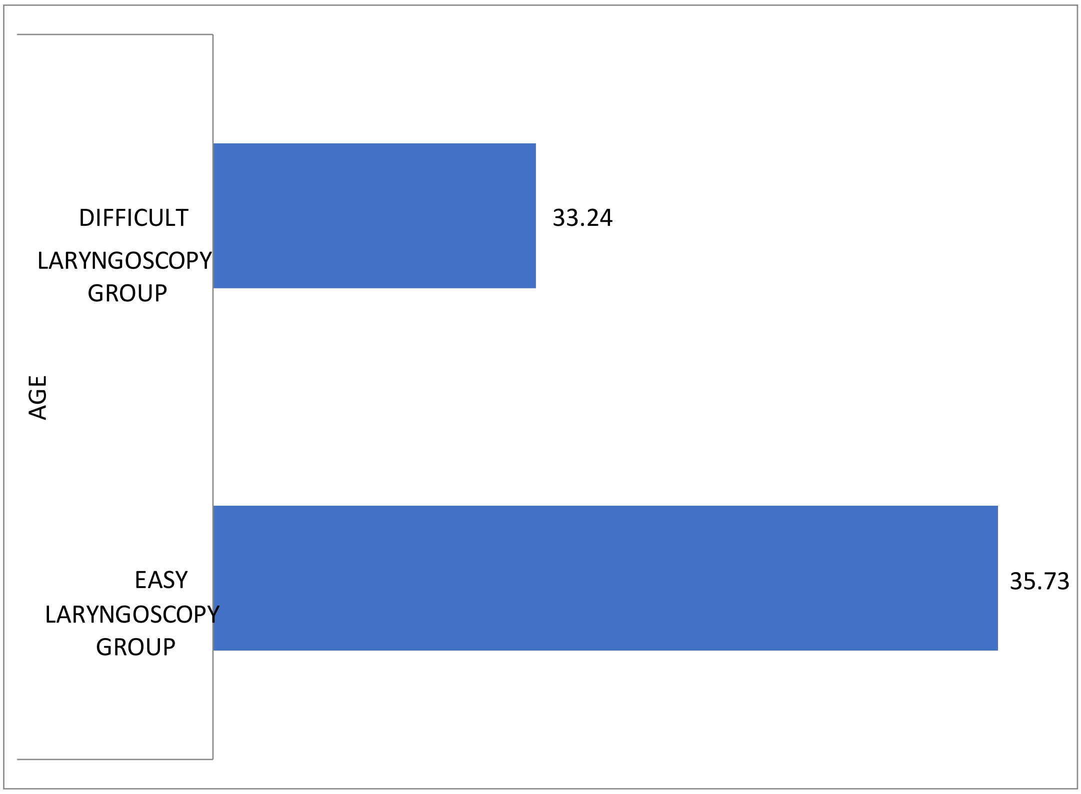
Figure 31: Illustration of study flow chart and outcome

Table 1 : Distribution of patients according to age

PARAMETER	AGE		P Value
	EASY LARYNGOSCOPY GROUP	DIFFICULT LARYNGOSCOPY GROUP	
N	51	21	0.63
Mean±SD	35.73±12.46	33.24±12.48	

N-number, SD- Standard Deviation

Age wise distribution of the sample revealed that there is no statistical significance as the p value is 0.63.



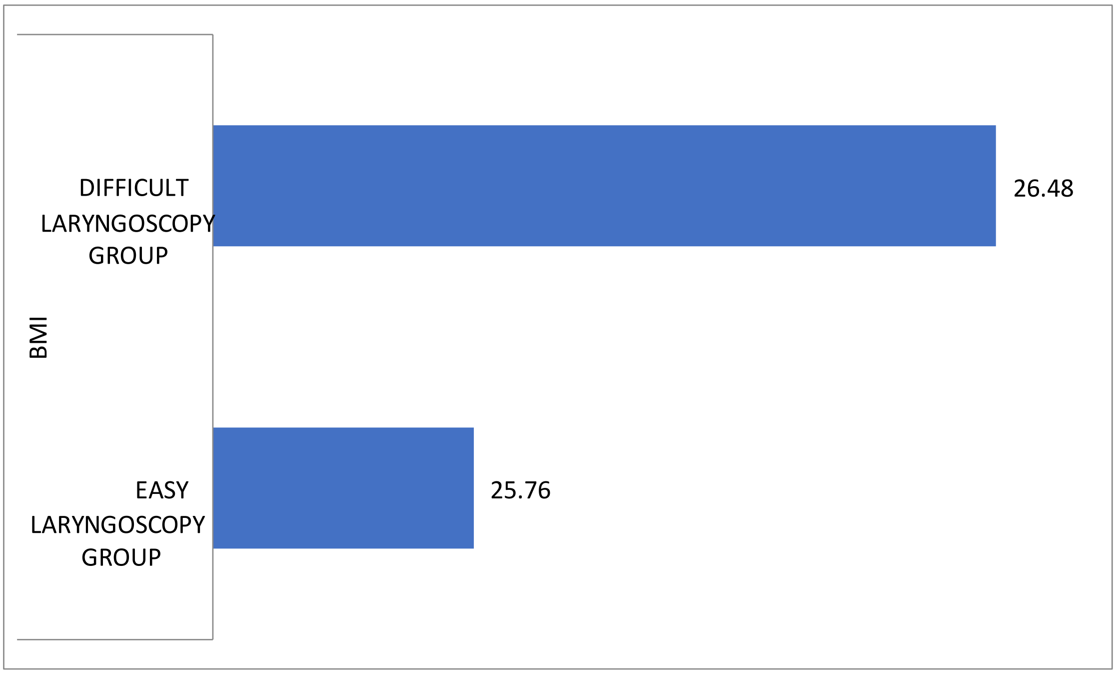
Graph 1: Distribution of patients according to age

Table 2 : Distribution of patients according to BMI

PARAMETER	EASY LARYNGOSCOPY GROUP	DIFFICULT LARYNGOSCOPY GROUP	P value
N	51	21	0.78
Mean±SD	25.76±4.10	26.48±4.32	

BMI – Body Mass Index, SD-Standard Deviation

BMI was represented as Mean ±SD.The p value of 0.78 determined it was statistically insignificant.



Graph 2: Distribution of patients according to BMI

The mean BMI in Difficult laryngoscopy was 26.48±4.32 and in Easy Laryngoscopy was 25.76 ± 4.10.

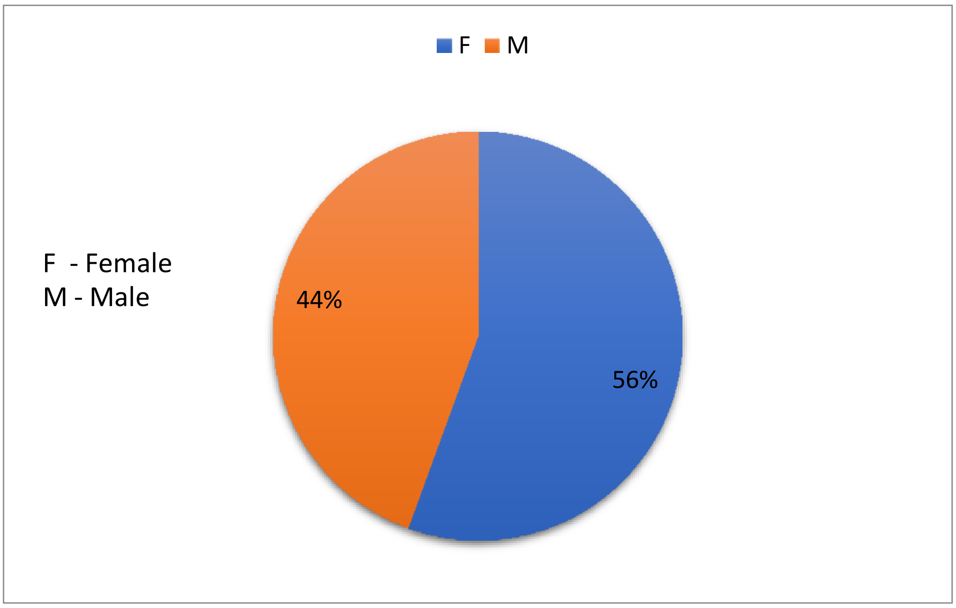
The mean BMI in both the groups were comparable though statistically insignificant.

Table 3 : Gender wise patient distribution in the groups

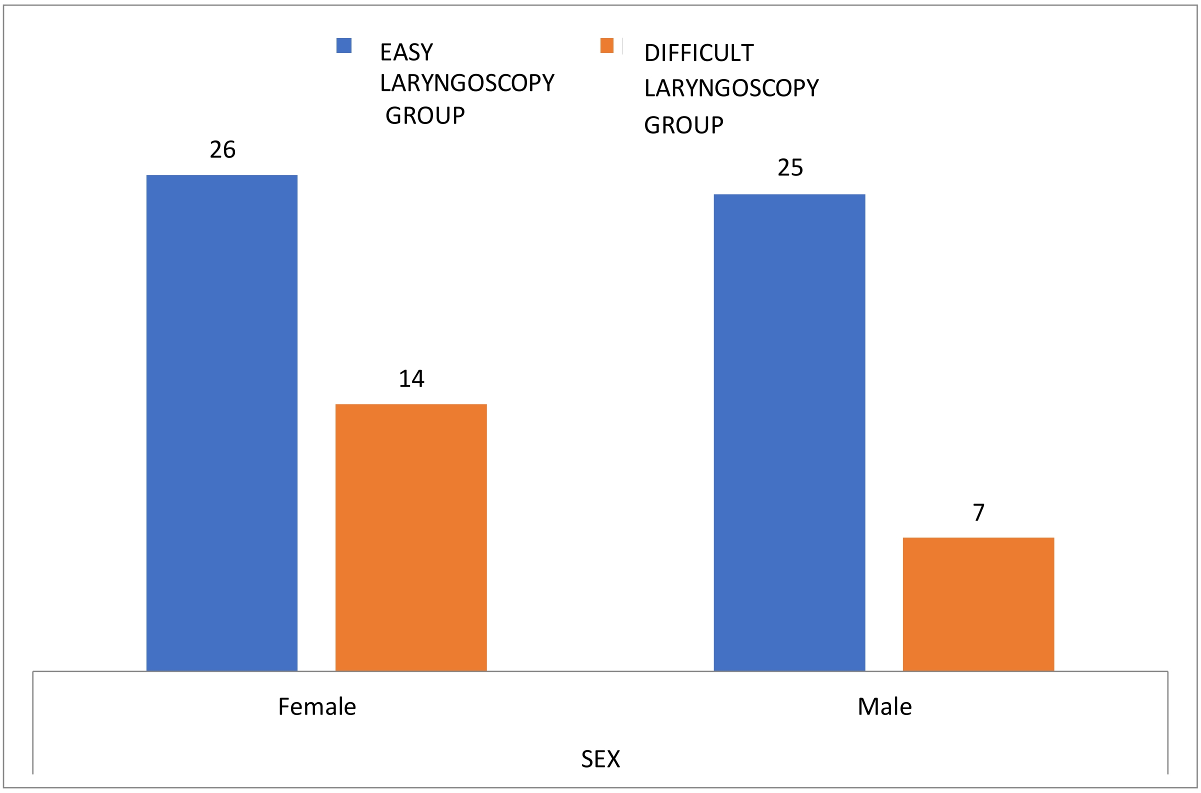
PARAMETER	SEX			p value
	EASY LARYNGOSCOPY GROUP	DIFFICULT LARYNGOSCOPY GROUP	TOTAL	
Female (N)	26	14	40	0.17
%	65%	35%	100%	
Male(N)	25	7	32	
%	78.13%	21.87%	100%	

N – Number

- Percentage of female were 65% and 35 % in Easy and Difficult laryngoscopy group respectively
- Percentage of males were 78.13 % and 21.87% in Easy and difficult laryngoscopy group respectively.
- P value of 0.17 indicated absence of statistical significance here.



Graph 3: Frequency of gender distribution



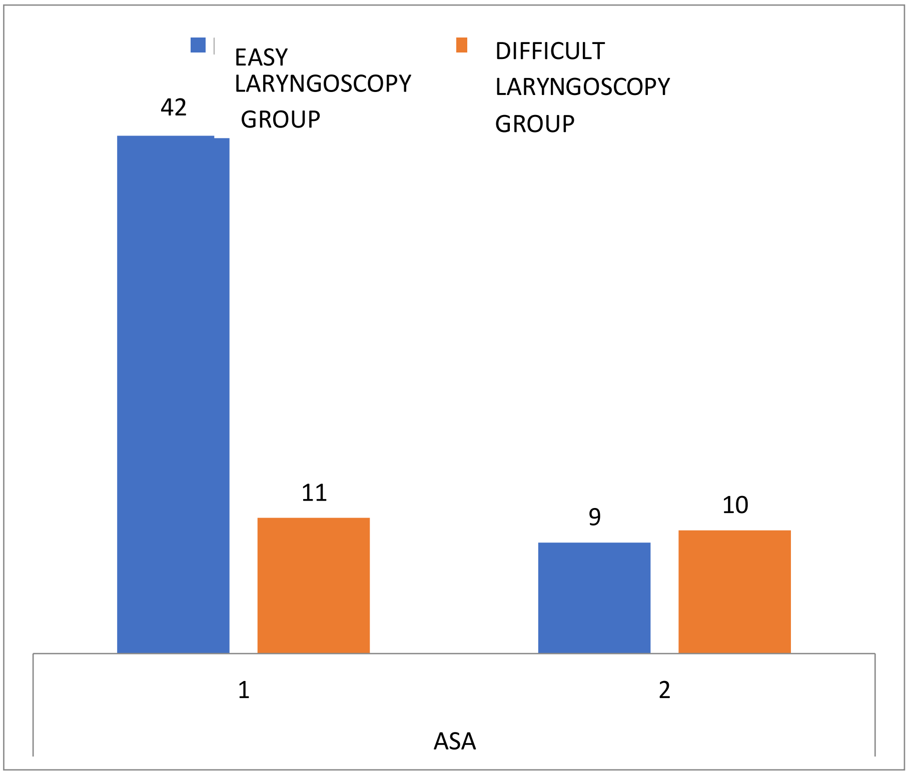
Graph 4: Genderwise distribution in easy and difficult laryngoscopy groups

Table 4:ASA grade distribution in easy and difficult laryngoscopy group

PARAMETER	ASA				p value
	1		2		
	N	%	N	%	
EASY LARYNGOSCOPY GROUP	42	79.25%	9	47.3%	0.2
DIFFICULT LARYNGOSCOPY GROUP	11	20.75%	10	52.7%	
Total	53	100%	19	100%	

ASA- American Society of Anesthesiologists physical status classification score, N – Number

- Chi -square test was applied and p value of 0.2 was obtained which denoted statistical insignificance.



Graph 5 :ASA grading in easy and difficult laryngoscopy groups

- Percentage of ASA grade 1 patients were 79.25% and 20.75% in Easy and Difficult laryngoscopy group respectively
- Percentage of ASA grade 2 patients were 47.3% and 52.7 % in Easy and difficult laryngoscopy group respectively.

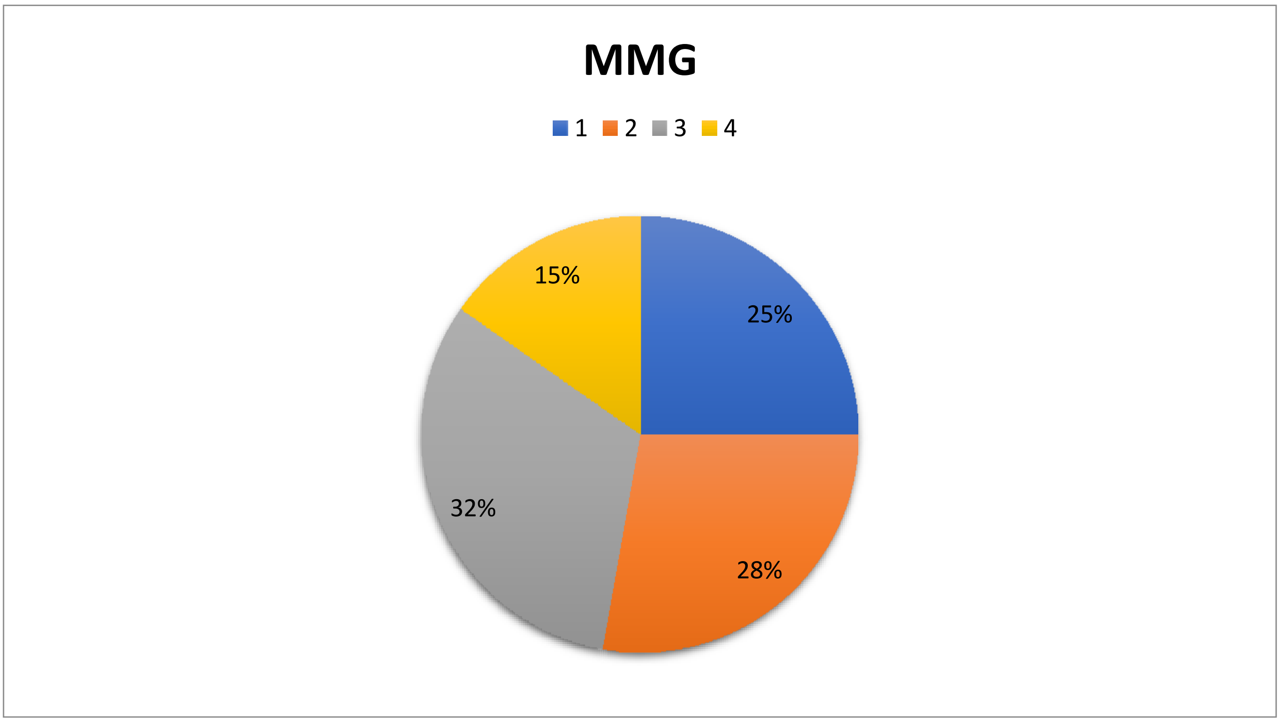
Table 5: Distribution of patients according to Modified Mallampatti Grading

PARAMETER	MMG								p value
	1		2		3		4		
	N	%	N	%	N	%	N	%	
EASY LARYNGOSCOPY GROUP	16	88	15	75	15	65.3	5	45.45	0.08
DIFFICULT LARYNGOSCOPY GROUP	2	12	5	25	8	34.7	6	54.55	
Total	18	100%	20	100%	23	100%	11	100%	

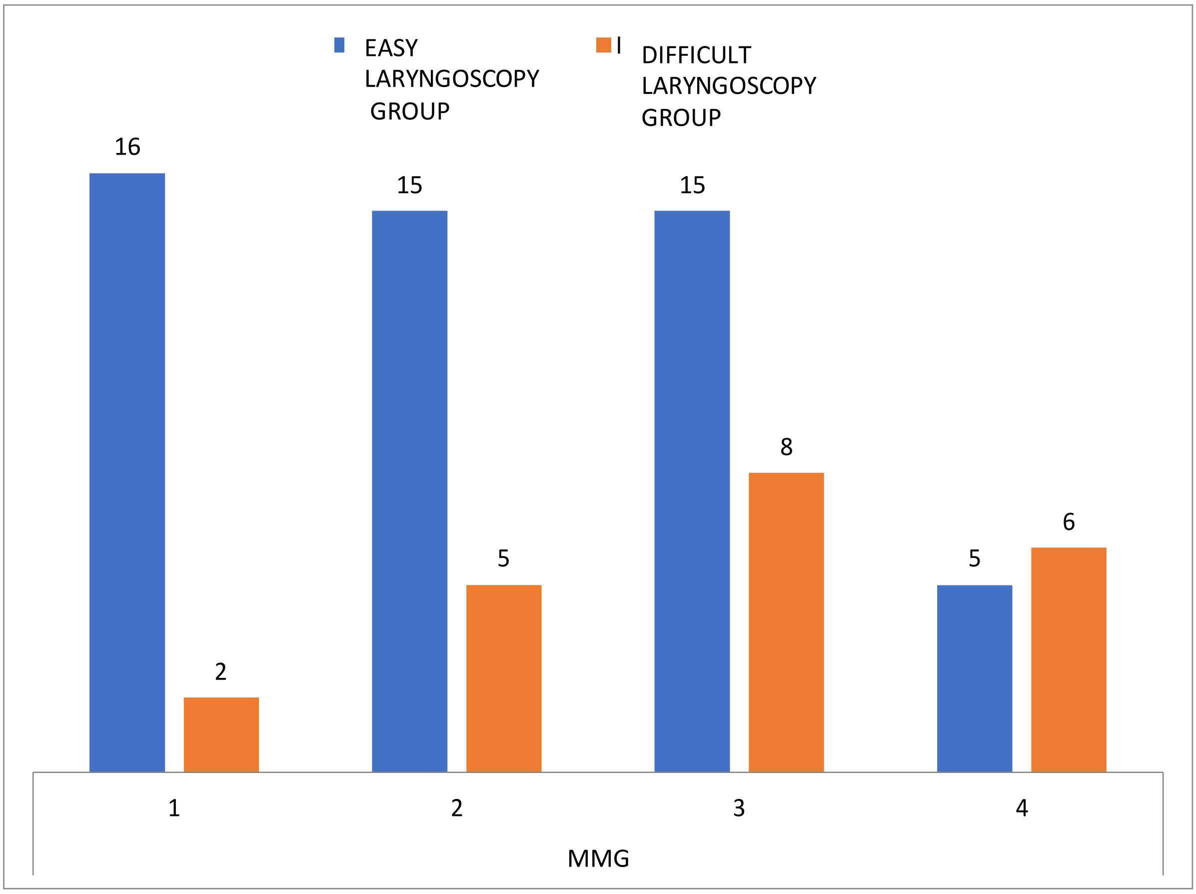
MMG – Modified Mallampatti Grade, N - Number

- In Grade 1, 88% and 12 % were easy and difficult laryngoscopy respectively.

- Whereas in Grade 2, 75% and 25% were easy and difficult laryngoscopy respectively.
- In Grade 3, 65.3% and 34.7% were easy and difficult laryngoscopy respectively.
- In Grade 4, 45.45 % and 54.55 % were easy and difficult laryngoscopy respectively.
- Here the p value of 0.08 was statistically insignificant.



Graph 6: Frequency distribution of Modified Mallampatti Grading



Graph 7: Distribution of patients according to Modified Mallampatti Grading

Table 6: Distribution of patients according to thyromental distance

PARAMETER	Thyromental distance				Total		p value
	< 6.5cm		> 6.5cm				
	N	%	N	%	N	%	
Difficult Laryngoscopy Group	19	42.2%	2	7.4%	21	29.2%	0.06
Easy Laryngoscopy Group	26	57.8%	25	92.6%	51	70.8%	

N-Number

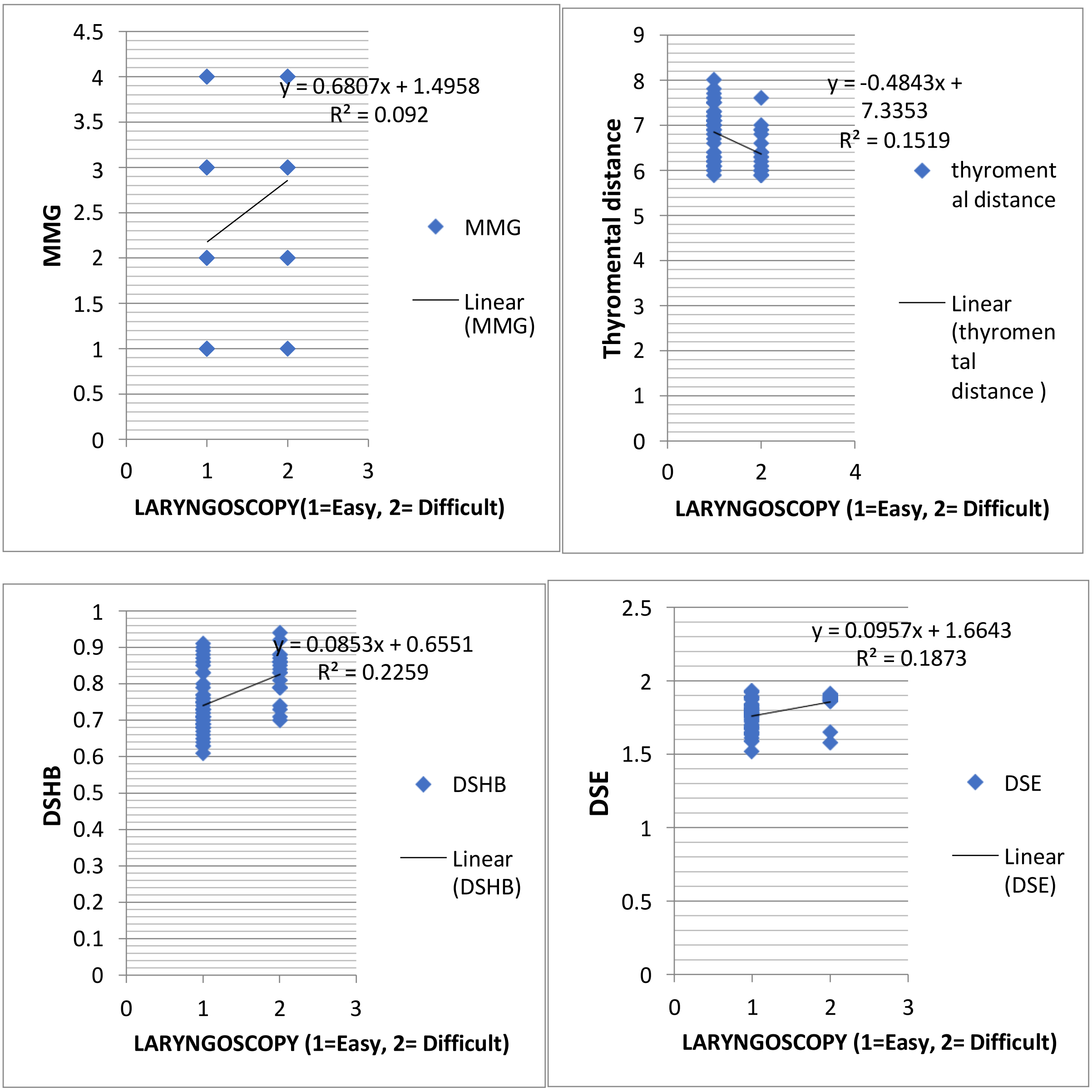
- In patients with thyromental distance less than 6.5cm ,42.2% were in difficult laryngoscopy group and 57.8% were in easy laryngoscopy group.

Table 7: Regression analysis for predicting difficulty in laryngoscopy

		95% CI		
PARAMETERS	OR	Lower Bound	Upper Bound	p Value
MMG	0.07	-0.01	0.16	0.10
Thyromental distance	-0.26	-0.37	-0.15	0.001
DSE	0.82	0.27	1.37	0.001
DSHB	1.82	0.82	2.81	0.001

MMG – Modified Mallampatti Grade , DSE- Distance of skin to epiglottis, DSHB – Distance of skin to hyoid bone

- The correlation coefficients along with 95% confidence of Thyromental distance, DSE and DSHB had p value of 0.001 indicating statistical significance .
- Modified Mallampatti Grading had a p value of 0.1 which indicated the absence of statistical significance.



Graph 8 : Relationships between ultrasound measurements of anterior neck soft tissue thickness and clinical tests in predicting difficult laryngoscopy

Table 8: Distribution of area under ROC curve for MMG, Thyromental distance, DSE, DSHB

PARAMETERS	Area under curve	Asymptotic 95% Confidence Interval		P Value
		Lower Bound	Upper Bound	
MMG	0.68	0.55	0.82	0.01*
Thyromental distance	0.24	0.12	0.36	0.001*
DSE	0.81	0.68	0.93	0.001*
DSHB	0.79	0.69	0.90	0.001*

***statistical significance**

- Area under the ROC curve for DSE and DSHB were significantly different from area under the reference line. DSE and DSHB had area under curve of 0.81 and 0.79 respectively.
- Area under curve for MMG and thyromental distance were 0.68 and 0.24 respectively.
- The p value of < 0.05 denoted statistical significance of all the tests .

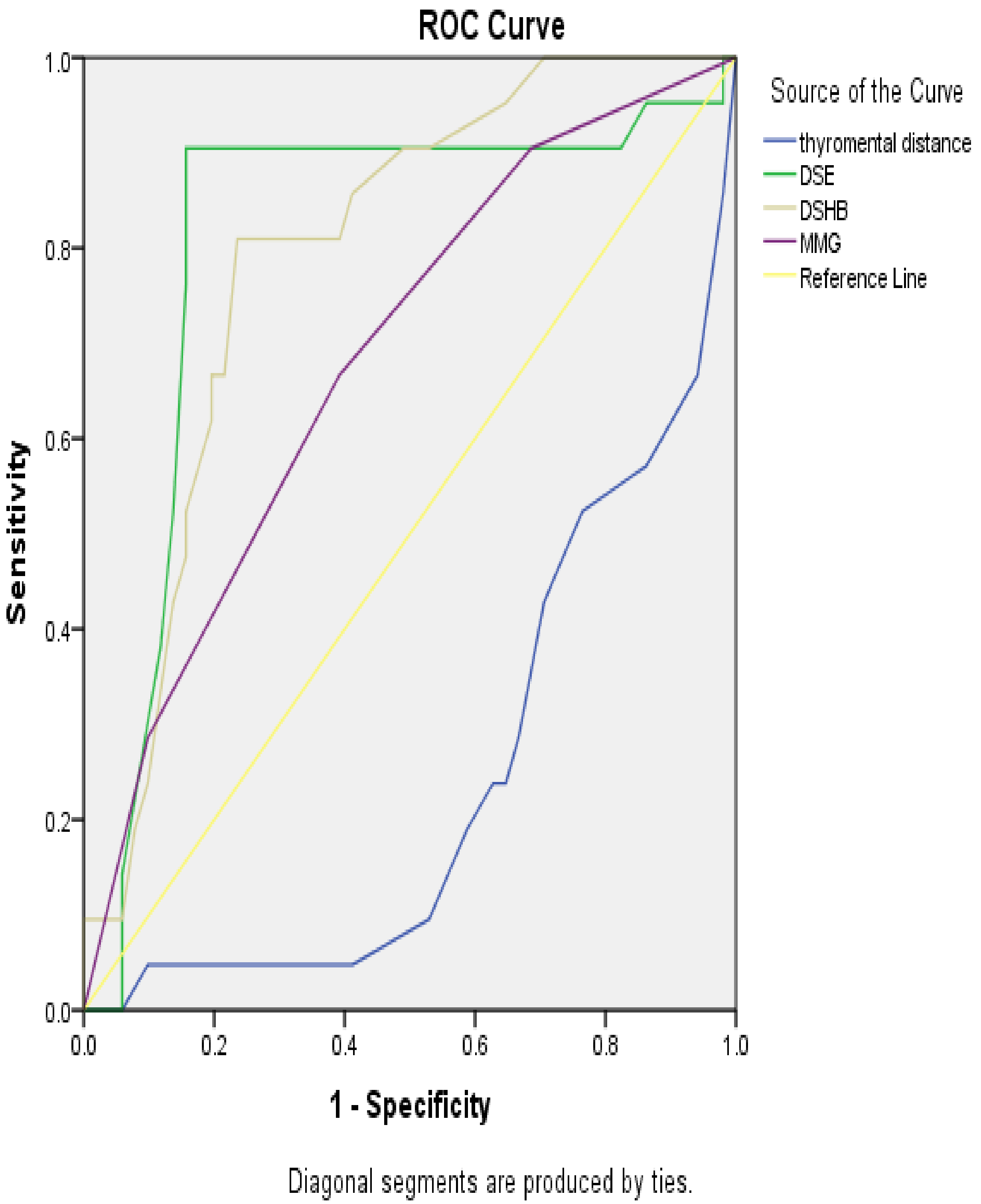


Figure 32 : ROC curve of the clinical and ultrasonographic airway assessment for predicting difficulty in laryngoscopy

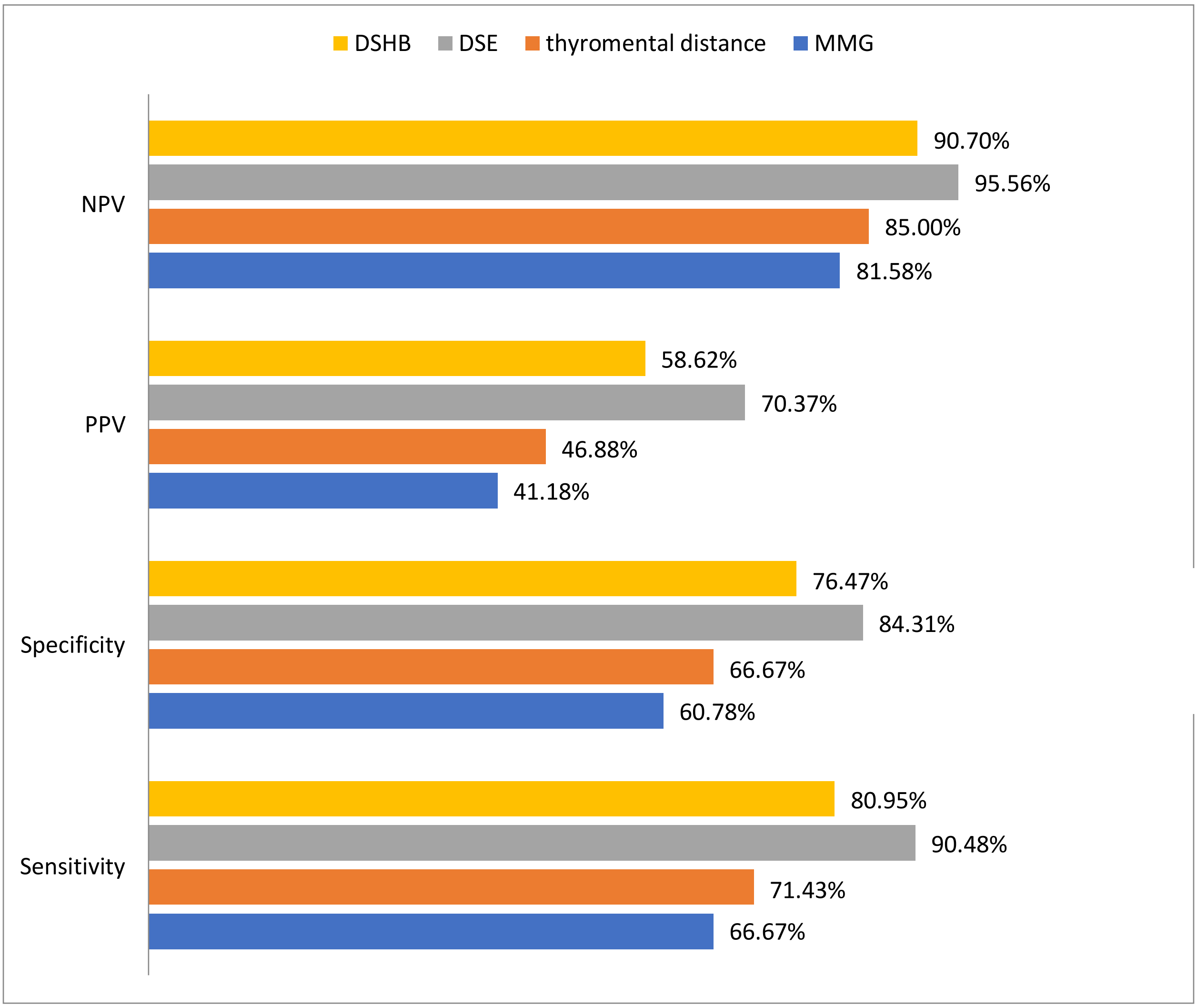
Table 9: Sensitivity, specificity, positive and negative predictive value of all clinical and ultrasonographic paramters

Variables	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Cut off value (cm)
MMG	66.67%	60.78%	41.18%	81.58%	>2
Thyromental distance	71.43%	66.67%	46.88%	85.00%	<6.5
DSE	90.48%	84.31%	70.37%	95.56%	>1.85
DSHB	80.95%	76.47%	58.62%	90.70%	>0.78

MMG- Modified Mallampatti Grade, DSE – Distance of skin to epiglottis, DSHB- Distance of skin to hyoid bone

- DSE and DSHB had significantly higher specificity and sensitivity when compared to Modified Mallampatti grading and Thyromental distance.
- Modified Mallampatti grading and thyromental distance had significantly less positive predictive value when compared to DSE and DSHB.
- DSE had the highest sensitivity and specificity of 90.48% and 84.8% respectively whereas modified Mallampatti grading had least sensitivity and specificity of 66.67% and 60.78% respectively.

Graph 9: Sensitivity, Specificity, Positive Predictive value (PPV) and Negative Predictive value (NPV) of ultrasound and clinical parameters



DISCUSSION

Endotracheal intubation is an essential life saving skill which every anaesthesiologist should have mastered, while being observant and prepared to manage any difficult airway scenario.[31] The difficult airway encountered may be due to various factors that maybe patient related, based on history of surgeries underwent, airway assessment, the clinical scenario requiring airway to be secured and the patient's current condition.[32]

Adequate practice, experience, judgement and evaluation are required for predicting the difficulty of a patient's airway and for planning management of the same. When a patient's airway is assessed to be easy to manage, it is expected that a well trained and adequately skilled anaesthesiologist will be able to carry out the procedure without complications. Difficult airways needs adequate preparation and planning as well as utilisation of infrequently used methods. Airway evaluation is subjective and skilled anaesthesiologists can also face challenging scenarios due to inaccurate prediction of difficulty in airway management. There are studies which suggest greater than 91% of airway difficulty is unpredicted. [33]

This prospective observational study aimed to assess the predictive value of ultrasonographic parameters such as DSE and DSHB and clinical parameters such as thyromental distance and modified Mallampatti score in total 72 adult patients in the age group of 18 to 60 years , scheduled for elective surgery under general anaesthesia.

Our first objective was to evaluate the ability of ultrasound parameters in difficult laryngoscopy prediction along with conventional clinical parameters. Our findings were similar to other studies conducted by Justin S. Fulkerson et al[34] to assess the use of ultrasonography for detecting difficulty of intubation where the relevance for ultrasonographic parameters for predicting difficulty in laryngoscopy occurred at 3 sites. Our findings also matched those of Vishal Koundal et al[4] conducted a study which observed the significant association of the ultrasound parameters in predicting difficulty in laryngoscopy. Our findings were also similar to the study by Osman Adi et al[35] where it was concluded that point of care ultrasound of the upper airway has a potential use as an adjunct in airway assessment. Adhikari et al [17] showed that ultrasonographic measurements of thickness of soft tissue in neck anteriorly may be used to identify difficulty in laryngoscopy.

The secondary objective was to assess the predictive value of ultrasonographic parameters such as the distance between skin to epiglottis (DSE) and distance from skin to the hyoid bone (DSHB) and conventional clinical parameters such as modified mallampatti score and thyromental distance in difficult laryngoscopy. Similar to the findings in our study, the study conducted by J.Pinto et al[36] demonstrated that the distance from skin to epiglottis can be used to predict difficult laryngoscopy and demonstrated a cut off of 2.75cm for the same. The study concluded that when combined with the modified Mallampati score it increased the predictive power over each test individually.

The study conducted by ECR Moura et al [37] demonstrated that the skin - epiglottis distance (p = 0.019) were statistically significant when comparing the easy airway and the difficult airway groups of the Cormack-Lehane classification with the predictive value of the skin - epiglottis distance for difficult airway assessment being 2.9 cm. These findings were similar to our study where the distance from skin to epiglottis had a p value of 0.001 with 1.85 cm being the cut off value to differentiate between easy and difficult laryngoscopy.

LH Lundstrom et al[38] observed that Modified Mallampatti score is inadequate to act as an individual test for determining difficult laryngoscopy but may be used as a part of multiple tests used for prediction of difficult laryngoscopy. T Randell et al [39] observed that the predictive value increases when a combination of tests are used as the sensitivity of each test such as Mallampati classification and the thyromental distance have been reported to be from 42% to 81%, and from 62% to 91% respectively whereas the specificity have varied from 66% to 84% and from 25% to 82% respectively. Evidently, the positive predictive value is improved, if combinations of tests are used. In our study we found sensitivity and specificity of Modified Mallampatti grading to be 66.67 % and 60.78% respectively, whereas thyromental distance had a sensitivity of 71.43% and specificity of 66.67%. T Shiga et al [40] in their study found that tests predicting difficult laryngoscopy were more relevant on combining the Modified Mallampati score with the thyromental distance. Current clinical parameters used for assessing difficult laryngoscopy have predictive value which ranges from poor to moderate when used individually. When the tests were combined it increased the predictive power value rather than when applied alone. The value of conventional airway assessment tests alone for determination of difficult laryngoscopy has certain limitations which can be overcome by combining with ultrasonographic parameters.

Hongwei Ni[2] conducted a study in 211 patients and observed that ultrasonographic measurement of the distance from skin to epiglottis to be the most significant independent indicator for predicting difficult laryngoscopy in view of sensitivity of 81.8% and specificity of 85.6%. Similarly our studies showed that ultrasound measurement of distance from skin to epiglottis had the highest sensitivity and specificity of 90.48% and 84.8%.

In contrast to our study where a DSE value of more than 1.85 cm was used to predict difficult laryngoscopy, Martinez-Garcia et al[41] conducted a study demonstrating that DSE > 3cm had a sensitivity of 56.3% and specificity of 88.2% . Komatsu et al[42] demonstrated that thickness of soft tissues of neck measured by ultrasonography does not accurately help in predicting the difficulty faced during laryngoscopy in patient with obesity implying that the study findings cannot be applied in patients who are obese.

However our study had certain limitations. Primarily the sample involved in the study conducted were regional cases of southern part of India so the anatomical data may vary due to differences in race and ethnicity. Also factors such as experience of the anaesthetist performing laryngoscopy and equipments used for laryngoscopy may influence the glottic exposure and hence the Cormack Lehane grading. Also this study excluded the obese and pregnant patients who have higher risk of difficult laryngoscopy. Hence further research may be required to complete the validation analysis based on the findings of this investigation.

CONCLUSION

Ultrasound is a non invasive, safe, fast and reliable method which is recently being used to predict difficult airway. Commonly used screening tests for difficult airway prediction have poor to moderate predictive power when used alone. Hence the inclusion of ultrasonographic measurements in routine airway assessment can help in enhancing our potential to anticipate a difficult airway.

The results of this study showed that ultrasonographic measurements of neck soft tissue have better sensitivity and specificity than conventional clinical tests such as thyromental distance and Modified Mallampatti grading for airway assessment. Therefore should be considered as prerequisites for pre-operative airway assessment in addition to the conventional clinical parameters used.

SUMMARY

This prospective observational study titled **"EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY"** was carried out from January 2021 to August 2022 in the department of anaesthesiology at Shri. B. M. Patil Medical College and Hospital, B.L.D.E Deemed to be University, Vijayapura.

The study was designed to evaluate ultrasonography (USG) parameters with conventional clinical parameters for predicting difficult airway in adults scheduled for elective surgeries under general anaesthesia. The following were the objectives :

Primary objective: To evaluate the ability of ultrasound parameters in predicting difficult laryngoscopy.

Secondary objective: To measure the distance between skin to epiglottis (DSE) and distance from skin to the hyoid bone (DSHB) using ultrasound and conventional screening tools such as modified mallampatti score and thyromental distance in the prediction of difficult laryngoscopy.

The study population of 72 were randomly selected, screened and assessed , with patients between the age of 18 years to 60 years of ASA grade I and II.

The observations and results were analysed statistically and were as follows:

The demographic data was not statistically significant.

Modified Mallampatti grading had least sensitivity and specificity of 66.67% and 60.78% respectively.

DSE had the highest sensitivity and specificity of 90.48% and 84.8%.

Positive predictive value of ultrasonographic parameters DSE and DSHB were 70.37% and 58.6% respectively which was significantly higher than that of Modified Mallampatti grading (41.18%) and Thyromental distance (46.88%).

Thus in this study ultrasonographic parameters such as distance fom skin to epiglottis and skin to hyoid bone were concluded to have higher sensitivity and specificity than the conventional clinical tests such as thyromental distance and Modified Mallampatti grading .

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ANNEXURE: I

ETHICAL CLEARANCE CERTIFICATE

IEC/110-09/2021
22-01-2021

B.L.D.E. (DEEMED TO BE UNIVERSITY)
(Declared vide notification No. F.9-37/2007-U.3 (A) Dated. 29-2-2008 of the MHRD, Government of India under Section 3 of the UGC Act, 1956)
The Constituent College
SHRI. B. M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Institutional ethical committee of this college met on 11-01-2021 at 11 am to scrutinize the synopsis of Postgraduate students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revisnc version synopsis of the Thesis has been accorded Ethical Clearance

Title: Evaluation of ultrasonography with conventional clinical parateters for predicting difficult airway: A prospective observational study

Name of PG student: Dr Priya S Nair Department of Anaesthesiology

Name of Guide/Co-investigator: Dr Sridevi Mulimani, Associate Professor of Anaesthesiology

DR .S.V.PATIL
CHAIRMAN, IEC
Institutional Ethical Committee
B L D E (Deemed to be University)
Shri B.M. Patil Medical College,
VIJAYAPUR-586103 (Karnataka)

Following documents were placed before Ethical Committee for Scrutinization:

1. Copy of Synopsis / Research project
2. Copy of informed consent form
3. Any other relevant documents.

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ANNEXURE-II

SAMPLE INFORMED CONSENT FORM

B.L.D.E.U's SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, BIJAPUR-586103,KARNATAKA

TITLE OF THE PROJECT: **EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY**

PRINCIPAL INVESTIGATOR: Dr.PRIYA.S.NAIR

Department of Anaesthesiology

BLDE University's Shri B M Patil Medical College &

Research Center, Sholapur Road Vijayapura-03

E mail: priyasn08@gmail.com

PG GUIDE : Dr SRIDEVI MULIMANI

M.D ANAESTHESIOLOGY

Professor

Department of Anaesthesiology

BLDE University's Shri B M Patil Medical College &

Research Center, Sholapur Road Vijayapura-03

PURPOSE OF RESEARCH:

I have been informed that this study is EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY. I have been explained about the reason for doing this study and selecting me as a subject for this study. I have also been given free choice of either being included or not in the study.

PROCEDURE:

I understand that I will be participating in the study EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY.

RISKS AND DISCOMFORTS:

I understand that my ward may experience some discomfort during the procedure and I understand that necessary measures will be taken to reduce them

BENEFITS:

I understand that my participating in this study will help in finding out EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY

CONFIDENTIALITY:

I understand that medical information produced by this study will become a part of this hospital records and will EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY be subjected to the confidentiality and privacy regulation of this hospital.

If the data are used for publication in the medical literature or for teaching purpose, no names will be used and other identities such as photographs and audio and video tapes will be used only with my special written permission. I understand that I may see the photograph and videotapes and hear audiotapes before giving permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr.PRIYA.S.NAIR is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of this study, which might influence my continued participation.

If during this study ,or later I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. And that a copy of this consent form will be given to me for keep for careful reading.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital.

I also understand Dr. PRIYA.S.NAIR will terminate my participation in this study at any time after she has explained the reason for doing so and has helped arrange for my continued care by my own physician or therapist, if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely events of injury to me/my ward, resulting directly due to my participation in this study, such injury will be reported promptly, then medical treatment would be available to me, but no further compensation will be provided.

I understand that by my agreement to participate in this study, I am not waiving my legal rights. I have explained to____the purpose of this research , the procedure required and the possible risk and benefits, to the best of my ability in patients own language

DATE Dr.PRIYA.S.NAIR

(investigator)

PATIENT SIGNATURE Witness

STUDY SUBJECT CONSENT STATEMENT:

I confirm that Dr.PRIYA.S.NAIR has explained to me the purpose of this research, the study procedure that I will undergo and the possible discomforts and benefits that I may experience, in my own language.

I have been explained all the above in detail in my own language and I understand the same. Therefore I agree to give my consent to participate as a subject in this research project.

_______________________ _______________

(participant) (date)

_________________________ ________________

(witness to above signature) (date)

ANNEXURE –III

SCHEME OF CASE TAKING

PROFORMA

STUDY: EVALUATION OF ULTRASONOGRAPHY WITH CONVENTIONAL CLINICAL PARAMETERS FOR PREDICTING DIFFICULT AIRWAY: A PROSPECTIVE OBSERVATIONAL STUDY

Patient Details

Name Age Sex Height weight

Ward

Diagnosis

Surgical procedure

Past history

General physical examination:

Pallor icterus cyanosis clubbing lymphadenopathy edema

Vital parameters:

Pulse blood pressure respiratory rate temperature

Systemic Examination:

CVS

RS

CNS

PA

Investigations:

Hemoglobin: TLC: Platelet count:

Urine routine: HIV: HbsAg:

ASA grade

PARAMETERS		**EASY LARYNGOSCOPY GROUP**	**DIFFICULT LARYNGOSCOPY GROUP**
MALLAMPATTI SCORE	I		
	II		
	III		
	IV		
THYROMENTAL DISTANCE	<6.5 cm		
	>6.5 cm		
US -DSE	<1.85cm		
	>1.85cm		
US – DSHB	<0.78cm		
	>0.78cm		

BIO-DATA

GUIDE NAME: Dr. SRIDEVI MULIMANI

DATE OF BIRTH: 11/11/1966

EDUCATION: MBBS-1990

KIMS, HUBLI

DIPLOMA IN ANASESTHESIOLOGY-1993

KIMS,HUBLI

MD ANAESTHESIOLOGY-2007

SHRI B M PATIL MEDICAL COLLEGE HOSPITAL AND

RESEARCH CENTER, VIJAYAPUR, KARNATAKA

DESIGNATION: PROFESSOR

DEPARTMANT OF ANAESTHESIOLOGY

TEACHING: UG TEACHING-27YRS

PG TEACHING-13YRS

ADDRESS: PROFESSOR

DEPARTMENT OF ANAESTHESIOLOGY B.L.D.E.U'S

SHRI B.M. PATIL MEDICAL COLLEGE AND RESEARCH

CENTER,VIJAYAPUR-586103

KARNATAKA

(08352)262770 EXT 2052, 08352-263266(R)

944953421

INVESTIGATOR

NAME: Dr PRIYA.S.NAIR

QUALIFICATION: M.B.B.S, M.S.RAMAIAH MEDICAL COLLEGE

KMC REG.NO: 118609

ADDRESS: DEPARTMENT OF ANAESTHESIOLOGY

B.L.D.E.U'S SHRI B.M.PATIL MEDICAL COLLEGE

HOSPITAL AND RESEARCH, 586103,KARNATAKA

MASTERCHART OF THE STUDY

SL No	AGE	SEX	BMI	ASA GRADE	MMG	TMD	DSE	DSHB	GROUP
1. I	48	F	26	1	3	6.4	1.8	0.63	E
2.	42	F	30.5	1	2	6.2	1.84	0.86	E
3.	57	F	29.8	1	2	6.1	1.81	0.69	E
4.	28	M	31.6	1	3	6.2	1.79	0.87	E
5.	35	F	23.5	1	3	6	1.68	0.71	E
6.	42	F	33.7	1	3	7.5	1.65	0.77	E
7.	45	F	32	1	3	7.1	1.78	0.75	E
8.	19	M	23.2	1	4	7.6	1.9	0.79	D
9.	19	M	27	1	3	7.2	1.89	0.73	E
10.	24	M	30.3	1	4	6.4	1.77	0.7	E
11.	22	M	26.8	1	3	6.3	1.83	0.71	E
12.	40	F	29.2	2	2	7	1.91	0.81	D
13.	25	F	19	1	1	6.2	1.84	0.75	E
14.	53	M	28.1	2	3	6.1	1.7	0.67	E
15.	42	F	30.8	1	3	6.9	1.86	0.86	D
16.	26	M	29.4	2	3	7.1	1.76	0.71	E
17.	36	M	21.4	1	3	7	1.68	0.76	E
18.	36	F	27.1	2	2	6.8	1.88	0.87	D
19.	40	F	26.4	1	2	6.1	1.93	0.83	E
20.	22	F	22.8	1	4	5.9	1.89	0.7	D
21.	49	F	28.8	1	1	7.6	1.69	0.68	E
22.	31	F	26.9	1	3	6.2	1.75	0.69	E
23.	58	F	28	2	1	6	1.87	0.86	D
24.	25	M	24.5	1	2	7.7	1.81	0.71	E
25.	23	M	18.8	1	4	6.4	1.87	0.88	D
26.	48	M	32.1	2	4	6.3	1.83	0.72	E
27.	40	M	34.2	2	3	6.2	1.87	0.86	D
28.	19	M	25.1	1	3	7.8	1.8	0.88	E
29.	58	M	33.2	2	4	6.3	1.89	0.83	D
30.	29	M	29.1	1	1	7.6	1.76	0.7	E
31.	18	M	19.3	1	2	7.5	1.79	0.66	E
32.	22	F	21.5	2	3	6	1.86	0.79	D
33.	35	M	27.4	1	2	7.5	1.61	0.73	E
34.	28	M	24.3	1	2	8	1.78	0.68	E
35.	45	F	29.3	1	2	7.5	1.67	0.71	E
36.	21	F	19.3	1	1	7	1.82	0.77	E
37.	45	F	27.9	1	3	5.9	1.87	0.84	D
38.	35	M	25.3	1	3	6.1	1.89	0.74	D
39.	51	F	31	2	2	6.6	1.88	0.94	D
40.	36	M	21	2	4	6.4	1.58	0.71	D
41.	28	F	24.3	1	2	6.9	1.86	0.73	D
42.	48	F	24.4	1	2	7.2	1.59	0.69	E
43.	50	M	25	2	4	7.3	1.8	0.85	E
44.	55	F	26.1	2	1	7.1	1.78	0.86	E
45.	22	F	19.2	1	2	6.6	1.67	0.89	E
46.	21	M	26.1	1	3	6.3	1.91	0.86	D
47.	20	F	20.5	1	2	6.9	1.74	0.68	E
48.	34	M	27.1	1	1	7.1	1.89	0.63	E
49.	42	M	21.3	2	4	7.2	1.76	0.76	E
50.	45	M	31.6	1	2	7	1.92	0.69	E
51.	45	F	26.6	1	1	6.1	1.77	0.73	E
52.	18	F	19.1	1	1	6.4	1.65	0.83	D
53.	33	F	25.9	1	4	6	1.87	0.85	D
54.	50	F	35	2	1	7	1.93	0.74	E
55.	50	M	24.3	1	2	6	1.65	0.72	E
56.	20	M	29.2	1	1	6.7	1.89	0.61	E
57.	26	M	27.2	1	3	6.9	1.81	0.68	E
58.	25	F	28.9	2	3	5.9	1.89	0.79	D
59.	22	M	22	1	1	6.8	1.72	0.71	E
60.	29	F	25.8	1	2	5.9	1.88	0.73	E
61.	53	M	23.8	2	1	7	1.64	0.83	E
62.	27	M	24.6	1	1	6.2	1.87	0.7	E
63.	46	M	22.8	1	3	7.1	1.7	0.91	E
64.	18	F	21.2	1	1	6.3	1.63	0.75	E
65.	24	F	28.5	1	2	6.1	1.88	0.88	D
66.	22	F	29.2	2	3	6	1.89	0.92	D
67.	56	F	19.3	2	2	7.3	1.52	0.9	E
68.	21	F	21.8	1	1	6.9	1.59	0.75	E
69.	23	F	26.7	1	1	7.1	1.8	0.64	E
70.	35	F	19.9	1	3	6.8	1.64	0.65	E
71.	55	F	21.7	1	4	7	1.78	0.8	E
72.	40	F	25.3	1	1	7.3	1.73	0.79	E