EVALUATION OF EFFICACY OF ULTRASONOGRAPHIC AIRWAY PARAMETERS FOR PREDICTING DIFFICULT AIRWAY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA – A PROSPECTIVE OBSERVATIONAL STUDY

By

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BLDE (Deemed to be University), Vijayapura, Karnataka

In partial fulfilment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

ANESTHESIOLOGY

Under the guidance of

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ABSTRACT

Background and Aim: The sonographic assessment of airway in the preoperative period has encouraging results in predicting difficult laryngoscopy.

Materials and Methods: A prospective, observational study involving 174 patients who were scheduled for elective surgery that required tracheal intubation and general anaesthesia was carried out. Sonographic measurements were made of the pre-epiglottic space (Pre-E) depth and the E-VC (the midpoint of the vocal cord distance) between the epiglottis and the vocal cords. Similar to this, the head was placed in neutral and extended postures while the Hyomental distance ratio (HMDR) was determined sonographically. Pre-E/E-VC, HMDR's ability to predict difficult laryngoscopy (Cormack-Lehane [CL] Grade 3, 4) was the main aim. Correlating these metrics with CL grade was the secondary aim.

Results: Intubation difficulties were noted in 17.8% of patients. The mean ± standard deviation (SD) of the Pre-E/E-VC ratio was 1.25±0.38 for easy intubation (CL grade1,2) and 1.95±0.20 for difficult intubation (CL Grade 3 and 4) ($P < 0.001$). The HMDR mean ± SD for easy intubation was 1.30±0.05 (CL Grades 1, 2), and 1.16±0.05 (CL Grades 3 and 4) for difficult intubation ($P < 0.001$). When it came to predicting difficult laryngoscopy, pre-E/E-VC ratios greater than 1.90 cm showed an 92% sensitivity and an

85 % specificity, while HMDR values less than 1.16 had an 70% sensitivity and an 85% specificity ($P < 0.001$).

Conclusion: Compared to HMDR, the sonographic measurement of the Pre-E/E-VC ratio is a more accurate predictor of CL grading. Pre-E/E-VC ratio more than 1.90 corresponds to difficult laryngoscopy (CL Grade 3,4). Pre E/E-VC ratio can be used for accurately predicting CL grading than HMDR. Therefore, to predict a problematic airway, ultrasonography should be included in routine pre-anaesthetic examinations. Pre-E/E-VC and HMDR are useful indicators for predicting difficult airways.

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ABBREVIATIONS

ASA -American society of anaesthesiologists

TMD - Thyromental distance

SMD – Sternomental distance

ANS - anterior neck soft tissue thickness

DSHB - distance from skin to the hyoid bone

DSTHM - separation between the skin and the thyrohyoid membrane

DSTCM - separation between the skin and the thyroid cartilage

MPG - Mallampati Grading

HMD - Hyomental distance

TT - tongue thickness

DSE - distance from skin to the epiglottis

DSVC- distance from skin to the vocal cords

CL - Cormack-Lehane grading

Pre-E- Pre Epiglottic space

E-VC -Epiglottis to mid-point of vocal cord

HMDN-Hyomental distance in head neutral position

HMDE- Hyomental distance in head Extension position

HMDR- Ratio between HMDN and HMDE

ETT – Endotracheal tube

SGA – supra-glottic airway

CICV - cannot intubate cannot ventilate

ULBT - upper lip bite test

POCUS - point-of-care ultrasound

CTM - cricothyroid membrane

DSE - distance between the skin and the epiglottis

CC - cervical circumference

Introduction

The accurate prediction of a difficult airway in patients posted for elective surgery under general anaesthesia is a critical component of preoperative planning and patient safety. The ability to foresee airway management challenges allows anaesthesiologists to strategize and implement appropriate interventions, thereby minimizing the risk of complications during anesthesia induction and intubation. Traditionally, physical examination techniques such as the Mallampati classification, thyromental distance (TMD), and neck circumference have been employed to assess airway difficulty. However, these methods have inherent limitations, including subjectivity and variability in predictive accuracy. Anatomical parameters such as ‘thyromental distance, mouth opening size, neck extension, jaw protrusion, and the upper lip bite test’ are used by the Wilson scoring system and the Samson and Young scoring system. However, it has been shown that the Cormack-Lehane categorization is the most trustworthy of these techniques [1].

The Cormack-Lehane categorization system is a popular way to characterize the image gained during direct laryngoscopy, an essential component of airway care. Based on the glottis's visibility, this classification assists anaesthesiologists in forecasting the intubation's level of difficulty. There are four grades in the system, with Grades 3 and 4 denoting more challenging intubations.

In recent years, ultrasonography has emerged as a valuable tool in the anaesthesiologist's arsenal, offering a non-invasive, objective, and reproducible means of evaluating airway anatomy. This introduction explores the evolution of ultrasonographic techniques in airway assessment, their methodological advantages, and their potential to enhance the predictive accuracy for difficult airways in patients undergoing elective surgeries. Ultrasonography, with its real-time imaging capabilities, allows for a detailed examination of the airway structures that are not visible through conventional physical examination. The 'anterior neck soft tissue thickness (ANS), the distance from skin to the hyoid bone (DSHB), the hyomental distance (HMD), the tongue thickness (TT), the distance from skin to the epiglottis (DSE), and the distance from skin to the vocal cords (DSVC)' are important ultrasonographic airway parameters.

These measurements provide critical insights into the anatomical variances that may predispose a patient to difficult intubation. The non-invasive nature of ultrasound, combined with its ability to provide dynamic and static measurements, makes it an attractive option for preoperative airway assessment. Furthermore, ultrasonography can be particularly beneficial in certain patient populations, such as those with obesity, head and neck tumour's, or previous cervical spine surgery, where traditional assessment techniques may be challenging or less reliable.

Research has shown that ultrasonographic parameters can enhance the prediction of difficult airways with greater sensitivity and specificity compared to traditional methods. For example, studies indicate that a thicker anterior neck soft tissue at the level of the vocal cords is often associated with difficult laryngoscopy. Similarly, measurements like the hyomental distance, when taken in head extension, provide high specificity, indicating a strong correlation between ultrasonographic findings and actual airway difficulty encountered during intubation. The integration of multiple ultrasonographic parameters further improves predictive accuracy, offering a comprehensive assessment of the airway that surpasses the limitations of single-parameter evaluations.

Despite the promising potential of ultrasonographic airway assessment, its efficacy depends significantly on the operator's expertise and the quality of the ultrasound equipment used. The adoption of ultrasonography in airway assessment represents a paradigm shift in anesthetic practice, aligning with the broader trend toward precision medicine. By providing a detailed anatomical assessment, ultrasonography helps tailor airway management strategies to individual patient profiles, thereby enhancing the safety and efficacy of anaesthetic care. This introductory overview sets the stage for a comprehensive evaluation of the efficacy of ultrasonographic airway parameters in predicting difficult airways.

Aim and Objective

❖ Aim

To compare the ultrasound-guided airway parameters HMDR i.e., the ratio of hyomental distance in the head in neutral and extended positions, and Pre-Epiglottic space to Epiglottis to mid-point of vocal cords (pre-E/E-VC) ratio as a predictor to assess the difficult laryngoscopy and correlate with Cormack-Lehane grading.

❖ Objectives

- **Primary Objective**

  To compare the ultrasound-guided airway parameters Hyomentoid ratio HMDR and Pre-Epiglottic space to Epiglottis to mid-point of vocal cords Pre-E/E-VC ratio as predictors of difficult laryngoscopy (Cormack–Lehane Classification 3, 4)

- **Secondary Objective**

  To correlate the ultrasonography-guided parameters with the clinical parameter Cormack–Lehane grading.

Anatomy and Physiology

Understanding the anatomy and physiology of the airway is essential for effective airway management. This knowledge allows to anticipate challenges, apply appropriate techniques, and utilize the correct tools to ensure safe and efficient airway control.

❖ **Anatomy of the Airway**

- **Upper Airway :**

✓ **Nasal Passages**: The nostrils and nasal cavity filter, warm, and humidify the air. Obstructions here can affect breathing and complicate intubation.

✓ **Oral Cavity**: Includes the mouth and structures such as the tongue, soft palate, and tonsils, which can impact airway patency.

✓ **Pharynx**: Divided into the nasopharynx, oropharynx, and laryngopharynx. Each section can be a potential site for obstruction, particularly in unconscious patients.

✓ **Larynx:** Contains the vocal cords and the glottic opening, which are critical landmarks during intubation. The epiglottis, a flap of cartilage, prevents food from entering the trachea during swallowing.

- **Lower Airway:**

✓ **Trachea**: A tube supported by cartilaginous rings extending from the larynx to the bronchi. Its rigid structure keeps the airway open but can be compressed by external pressure or swelling.

- ✓ **Bronchi and Bronchioles**: Branches from the trachea into the lungs, facilitating air movement into the alveoli where gas exchange occurs.

Physiology of the Airway

- **Ventilation:** Mechanics of Breathing: Involves the movement of air into and out of the lungs, driven by changes in thoracic pressure. Proper airway patency is essential for effective ventilation.
- **Muscle Activity**: The diaphragm and intercostal muscles play crucial roles in expanding and contracting the thoracic cavity. In certain conditions, accessory muscles of respiration may also be involved.
- Gas Exchange:
- **Oxygenation**: The respiratory system's main job is to carry oxygen into the blood and expel carbon dioxide. A blockage of any airway might affect gas exchange and result in hypoxia.
- o **Carbon Dioxide Removal**: Efficient ventilation ensures that carbon dioxide is expelled from the body, maintaining acid-base balance.
- **Protective Reflexes:**
- o **Coughing and Sneezing**: Reflexes that help clear the airway of irritants and secretions.
- o **Swallowing Reflex**: Prevents aspiration by coordinating the closure of the epiglottis during swallowing.

Airway Management

A deep sleep or coma brought on by general anaesthesia leaves the patient cognizant but numb. While some patients can continue to breathe on their own during this state, many are unable to do so consistently and require support from their anaesthesiologist. An endotracheal tube (ET tube) or a supraglottic airway (SGA), a device placed above the vocal cords, are frequently used in conjunction with other techniques to provide support. At times, this support can be as straightforward as a chin lift or jaw thrust to open the airway. The proper distribution of anaesthetic gases and oxygen is guaranteed by both apparatuses. A number of surgical and patient-related factors influence the device selection.

To be proficient in managing airways, the healthcare provider needs to comprehend the fundamental anatomical, physiological, and pathological features of the airway. Additionally, they need to be knowledgeable on the many instruments and methods created for airway management.

It is crucial to know the indications, contraindications, and potential complications of endotracheal intubation. Understanding how to confirm the correct placement of an endotracheal tube is essential. For safe and efficient airway management, it's also essential to understand the variations between adult, paediatric, and neonatal airways and to possess knowledge of managing challenging airways[2] .

'The four principals of airway management in Advanced Cardiovascular Life Support are

- Is the airway patent?
- Is the advanced airway indicated?
- Is the proper placement of the airway device confirmed?
- Is the tube secure, and is the placement of the tube confirmed frequently?'

Indication of Airway Management

Effective airway management is crucial in various clinical scenarios to ensure adequate ventilation and oxygenation. Indications for airway management in adults can be broadly categorized into several groups based on the underlying need or condition.

✓ **Surgical Procedures**

- **General Anaesthesia**: Most surgical procedures requiring general anaesthesia necessitate airway management to maintain a patent airway and provide controlled ventilation.
- **High-Risk Surgeries**: Procedures involving the head, neck, chest, or abdomen where airway compromise is anticipated, such as surgeries on the upper airway, thoracic surgeries, or major abdominal surgeries.

- ✓ **Respiratory Failure**

Hypoxemic Respiratory Failure: occurs when blood oxygen levels are insufficient (PaO_2 < 60 mmHg) even when oxygen supplements are given. Acute respiratory distress syndrome (ARDS), pneumonia, pulmonary oedema, and severe asthma are among the common causes.

- **Hypercapnic Respiratory Failure**: Characterized by elevated levels of carbon dioxide in the blood ($PaCO_2$> 50 mmHg), often due to conditions that impair ventilation, such as chronic obstructive pulmonary disease (COPD), drug overdose, or neuromuscular disorders.

- ✓ **Airway Protection**
  - **Loss of Protective Reflexes**: Situations where the patient has impaired or absent gag and cough reflexes, increasing the risk of aspiration. This can occur in patients with a decreased level of consciousness due to head injury, stroke, intoxication, or metabolic disorders.
  - **Obstruction Risk**: Presence of conditions that threaten to obstruct the airway, such as facial trauma, angioedema, anaphylaxis, or upper airway tumours.

✓ **Emergency Situations**

- **Cardiac Arrest**: Immediate airway management is essential during cardiopulmonary resuscitation (CPR) to secure the airway and facilitate effective ventilation and oxygenation.
- **Trauma**: Patients with severe trauma, especially those involving the head, neck, or chest, often require airway management to ensure adequate ventilation and protect against aspiration.

✓ **Diagnostic Procedures**

- **Bronchoscopy**: In certain diagnostic or therapeutic procedures involving the airway, such as bronchoscopy, securing the airway is necessary to ensure patient safety and procedure effectiveness.
- **Endoscopy**: Some gastrointestinal endoscopic procedures may also require airway management, particularly in patients at high risk of airway compromise.

Contraindications of Airway Management

While airway management is essential in many clinical situations, there are certain contraindications and considerations that healthcare providers must be aware of to avoid potential complications. Contraindications can be absolute or relative, depending on the patient's condition and the specific circumstances.

❖ **Absolute Contraindications**

- **Severe Facial Trauma:**
  - ✓ Description: Extensive injury to the face, particularly involving the nasal or oral cavities, can make conventional airway management techniques like orotracheal or nasotracheal intubation unsafe.
  - ✓ Risk: Increased risk of causing further injury, bleeding, or obstruction.

- **Basilar Skull Fracture:**
  - ✓ **Description**: Fractures at the base of the skull.
  - ✓ **Risk**: Nasotracheal intubation is contraindicated due to the risk of introducing the tube into the cranial vault.

- **Relative Contraindications**

✓ **Cervical Spine Injury:**

- o Description: Suspected or confirmed cervical spine injury.
- o Risk: Manipulation of the neck during intubation can exacerbate spinal injury. Special techniques or tools like video laryngoscopy or fiberoptic intubation may be necessary.

- ✓ **Severe Obstructive Pathology:**
  - Description: Conditions like large tumors, severe laryngeal edema, or airway anomalies.
  - Risk: Difficulty in passing the endotracheal tube through obstructed or distorted anatomy. Alternative methods such as tracheostomy may be considered.
- ✓ **Anticoagulation or Coagulopathy:**
  - Description: Patients on anticoagulant therapy or with clotting disorders.
  - Risk: Increased risk of bleeding during intubation, especially with techniques that may cause mucosal trauma.
- ✓ **Airway Infections:**
  - Description: Active infections such as epiglottitis or retropharyngeal abscess.
  - Risk: Intubation can exacerbate infection or cause airway trauma. Alternative airway management strategies should be considered.
- ✓ **Upper Airway Foreign Bodies:**
  - Description: Presence of foreign bodies in the upper airway.
  - Risk: Manipulation during intubation can dislodge or further obstruct the airway. Removal of the foreign body may be necessary prior to intubation.

Considerations and Alternative Strategies

- **Assessment and Planning:** Thorough preoperative assessment, including history, physical examination, and appropriate imaging, is critical to identify potential contraindications.
- **Alternative Techniques:** Techniques such as fibreoptic intubation, use of supraglottic airway devices, or surgical airway (tracheostomy) may be considered in cases where conventional intubation is contraindicated.
- **Preparation and Equipment:** Ensure all necessary equipment and support are available, including advanced airway management tools and emergency surgical airway kits.
- **Team Approach:** Involve a multidisciplinary team, including anaesthesiologist's, surgeons, and intensivists, to plan and execute the safest approach for airway management.
- **Patient-Specific Considerations:** Tailor the airway management approach to the individual patient's anatomy, pathology, and clinical situation to minimize risks and complications.

Difficult Airway

'A difficult airway is defined as the clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both as per ASA guidelines' [2].

The airways can be categorized as either non-emergency or emergency depending on whether problematic facemask ventilation is present or not. A non-emergency airway gives anaesthesiologist's sufficient time to think about different airway management strategies.

. On the other hand, an emergency airway entails challenging facemask ventilation in addition to challenging intubation, which puts patients at risk for hypoxia and, in extreme circumstances, a "cannot intubate, cannot ventilate" (CICV) scenario that could result in death or serious brain damage. The research currently in publication does not provide a consensus definition of a problematic airway.[3]

According to Heidegger, a difficult airway can involve challenging facemask ventilation, endotracheal intubation, placing a supraglottic airway device, or necessitating an emergency surgical airway that would be expected or encountered by a skilled clinician.[4] In 2022, the American Society of Anaesthesiologists (ASA) added "difficult or failed tracheal extubation" to its definition of individuals with a known or suspected difficult airway losing sufficient breathing and airway patency following the removal of a supraglottic airway device or endotracheal tube.[5]

The term "inadequate ventilation" was also introduced by the ASA guidelines. Its indicators included breathing sounds, chest movement, insufficient or absent carbon dioxide exhaled, signs of severe obstruction, cyanosis, gastric air entry or distention, decreasing oxygen saturation, and hemodynamic changes linked to hypoxemia or hypercarbia.

Additional symptoms may include altered mental status or somnolence, contributing to the concept of a “physiologically difficult airway.” This concept highlights that physiological dysfunction, in addition to anatomical factors, can complicate airway management, especially in critically ill patients who are at higher risk of complications and mortality during intubation.

Methods of difficult airway assessment

When assessing a problematic airway, one of the most crucial pieces of information is the patient's medical history. Congenital abnormalities affecting the face or mouth, rheumatoid arthritis, acromegaly, a history of head and neck radiation therapy, and obstructive sleep apnea syndrome are among the ailments that have been found to be closely linked to problematic airways [12–14].

According to recent studies, the most significant warning indicator for the subsequent airway management anaesthetist to see a patient is the patient's prior challenging airway diagnostic [15]. As a result, we highly advise nations to create a database of people experiencing respiratory difficulties [16]. Like an infectious disease control system, the database would include precise airway data for the patient as well as the management of the previous anaesthetist.

A few nations in North America and Europe have already created databases of challenging airways. In order to properly notify anaesthetist, they also employ unique visual warning indicators, like wristbands, for hospitalized patients who have been diagnosed with a problematic airway [17]. However, most of the world does not yet have established difficult airway databases. A straightforward bedside assessment is another conventional method of diagnosing a problematic airway. The anaesthetist evaluates the patient's mandibular and facial characteristics, including the upper lip bite test (ULBT), buck teeth, mouth opening, and modified Mallampati classification [18]. Simple anatomical measurements such as neck circumference, Hyomental distance, sternomental distance, and inter-incisor gap are also taken by the anaesthetist[19–21].

The selection of cutoff values and the variation in cutoff values across various subgroups are the two primary issues with bedside testing used to identify the existence of a difficult airway, respectively. anaesthetist must choose the right screening indices based on the patient and the region, as the cutoff values for various tests might differ significantly between age groups, gender, and ethnicity.

The Wilson score, the SARI score, and the modified LEMON score are examples of complete assessment algorithms that have been developed in response to the subjectivity and low accuracy of utilizing a single component to predict a problematic airway [21, 22]. Large fluctuations caused by assessor subjectivity will be reduced by employing numerous predictors, increasing the accuracy of challenging airway prediction.
These thorough assessment instruments are time-consuming and sophisticated, though, which makes it challenging to use them in regular practice. To enhance and streamline the pertinent factors, more study is accessible [23].

Ultrasonographic Assessment of Airway

In hospital emergency rooms (EDs), point-of-care ultrasound (POCUS) has become increasingly popular in recent years as a diagnostic tool and imaging guide for a variety of treatments [24]. Anaesthesiologists and Emergency Medicine (EM) clinicians view POCUS as an essential part of resuscitation due to its portability and good diagnostic accuracy in a wide range of applications [25]. Ultrasound's familiarity, accessibility, safety, and non-invasive nature have made it a potential technique for airway examination and management.

With objective measurements of airway parameters and dynamic real-time images to guide airway procedures, it can help anaesthetist discover pertinent anatomy [26, 27]. There are numerous instances of airway management with ultrasonography. Before intubation or procedural sedation, ultrasound can be utilized to evaluate the airway and identify patients who might have an unexpectedly difficult airway.

Additionally, it can be used to verify that an endotracheal tube (ETT) is placed correctly. This is crucial in circumstances like cardiac arrest where end-tidal capnography confirmation may not be trustworthy [28]. Furthermore, ETT misplacement, such as oesophageal or mainstem intubation, can be identified by ultrasound [29, 30].

The cricothyroid membrane (CTM) can also be found with ultrasonography, which is an important step in being ready for a "cannot intubate, cannot ventilate" situation [31]. In the case that intubation is not possible, anaesthetists can rapidly and accurately do a cricothyrotomy by using ultrasound to find the CTM.

Probe Selection and Technique

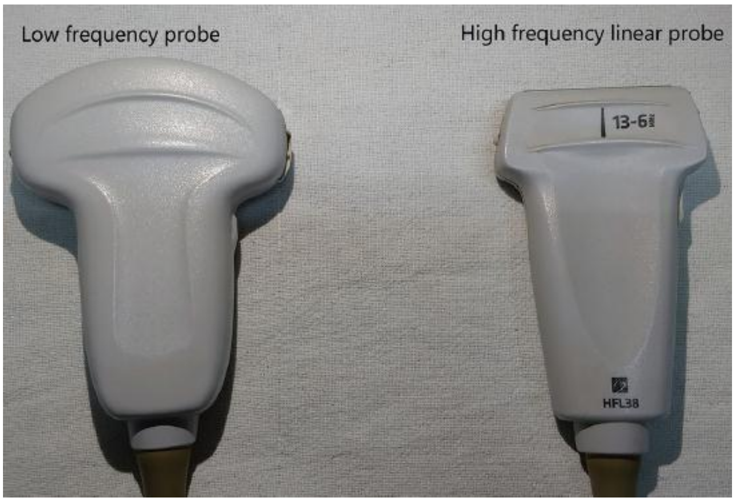
The linear and curvilinear ultrasonography probes are the two most often utilized ultrasonography probes for upper airway viewing. A typical 5–15 MHz high frequency linear probe is more suited for identifying surface tissues such the CTM, vocal cords, and epiglottis. Higher frequencies have a stronger ability to resolve surface structures, but they have a worse ability to resolve deeper structures, such the base of the tongue [32].

Because lower frequency soundwaves can enter deeper tissues, the typical 2–5 MHz curvilinear probe is more appropriate for assessing the tongue base [32]. Furthermore, the curvilinear probe should be used for some airway measures, such as the hyomental distance (HMD), since its longer length makes it easier to see the hyoid and mentum in a single image for precise distance measurement. There are three positions for the ultrasonic probe: transverse, sagittal, and parasagittal.

The suprasternal notch to the mentum is the range along which the upper airway can be assessed in both transverse and sagittal directions. A cricothyroidotomy, for example, is a midline procedure that may benefit from the parasagittal position. The patient's neck can be in a neutral, ramping, or hyperextended position when they are supine. It is generally easier to image a patient who is ramping and has their head extended since there is more surface area available to handle the probe. However, a seated or semi-recumbent position can also be used if the patient is experiencing respiratory distress. Enough gel should be used to lessen the pressure of the probe applied to the neck in order to prevent air pockets from accumulating between the protuberances of the tracheal rings and thyroid cartilage.

Vital vascular structures can be identified with Color Doppler. Anatomy can be more clearly explained through patient manoeuvres. For instance, having the patient swallow can help visualize the oesophagus, and having them phonate can assess the function of the voice cords.

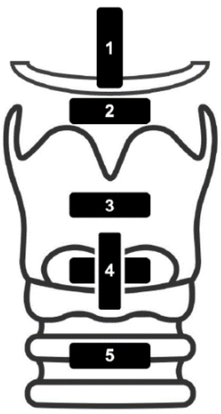
Figure 1 : Commonly Used Ultrasound probes for airway management



Upper Airway Sono-Anatomy

Important upper airway features, including the trachea, oesophagus, tracheal rings, cricoid cartilage, CTM, thyroid cartilage, vocal cords, hyoid bone, epiglottis, and tongue, can be identified using upper airway ultrasonography [33]. Furthermore, studies comparing ultrasonic measurements of the upper airway to cadaver models have demonstrated good levels of accuracy and dependability between and within operators [34]. The upper airway can be evaluated using the thyrohyoid, suprahyoid, thyroid, cricothyroid, and suprasternal views. Fewer perspectives can be chosen to address a specific concern, depending on the particular cause for upper airway examination.

Figure 2: Views to Assess the Upper Airway



Upper Airway POCUS Views and Main Function	
Suprahyoid view	Oral Spaces Assessment
Thyrohyoid view	Epiglottis Identification
Thyroid view	Vocal Cord Function
Cricothyroid view	CTM Identification
Suprasternal view	ETT Confirmation

1. **Suprahyoid View**

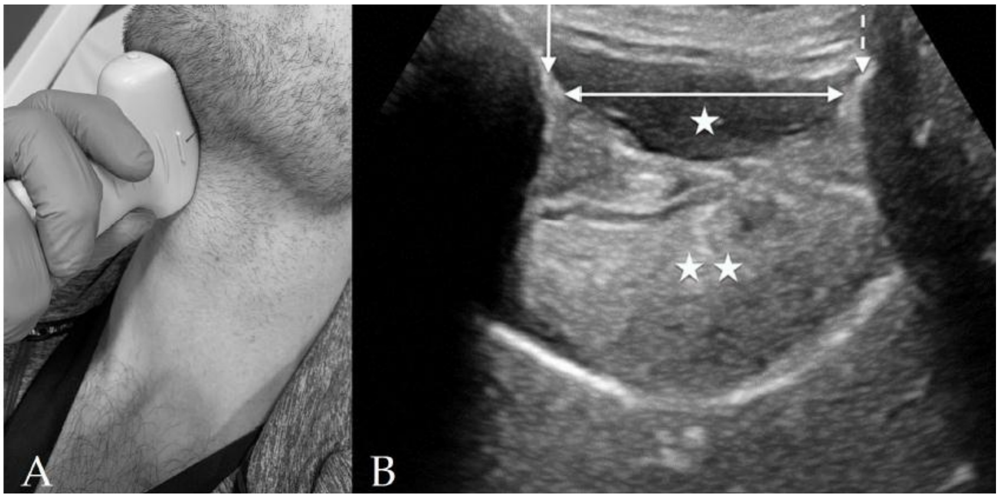


Figure 3. : A : Suprahyoid Probe Placement (In Sagittal Orientation) B : Anterior neck suprahyoid view using a sagittal-oriented, curvilinear probe and cranially directed probe indicator. The dashed arrow indicates the hyoid bone, whereas the solid arrow indicates the mandibular mentum. The tongue is located deep to the hypoechoic mylohyoid and geniohyoid muscles (single star and double star, respectively).

2. **Thyrohyoid View**

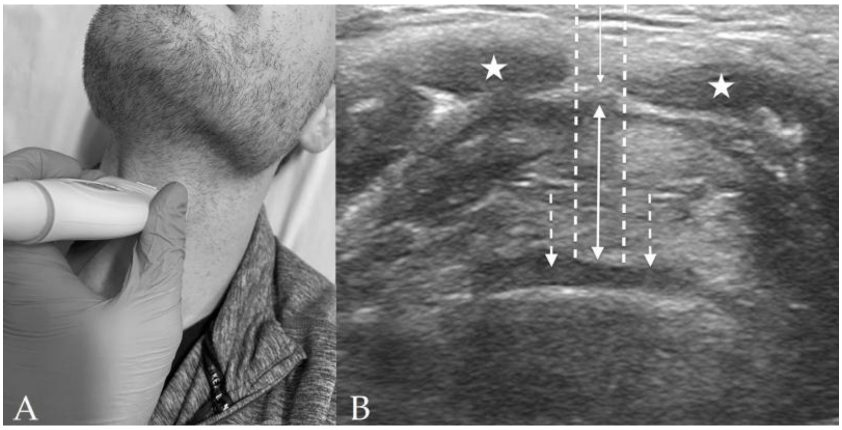


Figure 4 : **A**. Placing the probe on thyrohyoid region around the subject's neck. **B**. Thyrohyoid image of the anterior neck in transverse orientation using a linear probe. The thyrohyoid membrane (solid, single-headed arrow) and the epiglottis (dashed arrows) are separated by the pre-epiglottic gap (solid, double-headed arrow). The thyrohyoid membrane can once more be seen to have superficial access to the strap muscles, or stars. The two dashed lines represent the distance between the skin and the epiglottis(DSE).

3. **Thyrohyoid View**

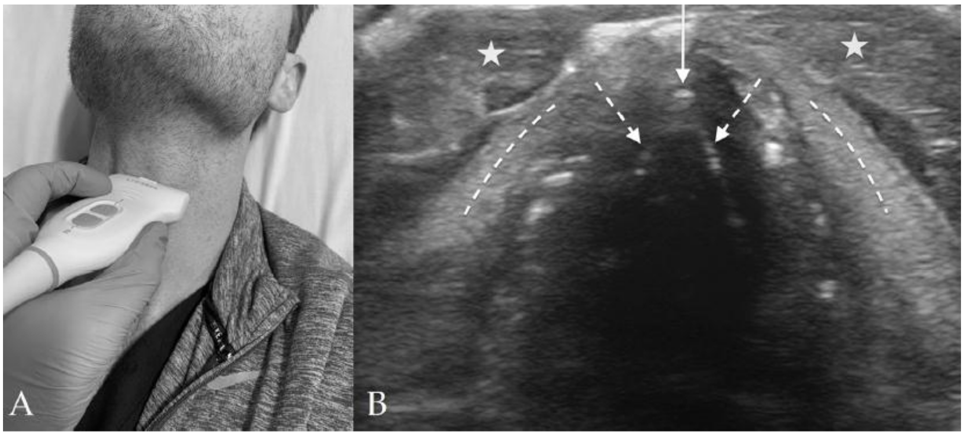


Figure 5 : A. Placing the probe on thyroid the patient's neck. B. Anterior neck thyroid image using a transversely oriented linear probe. The anterior commissure (solid arrow) is where the voice cords (dashed arrows) converge. The strap muscles (stars) are just superficial to the thyroid cartilage, while the thyroid cartilage (dashed lines) appears lateral to the vocal cords. The arytenoids will typically be seen near the posterior aspect of the bilateral voice cords, despite their poor visualization in this image.

4. **Cricothyroid View**

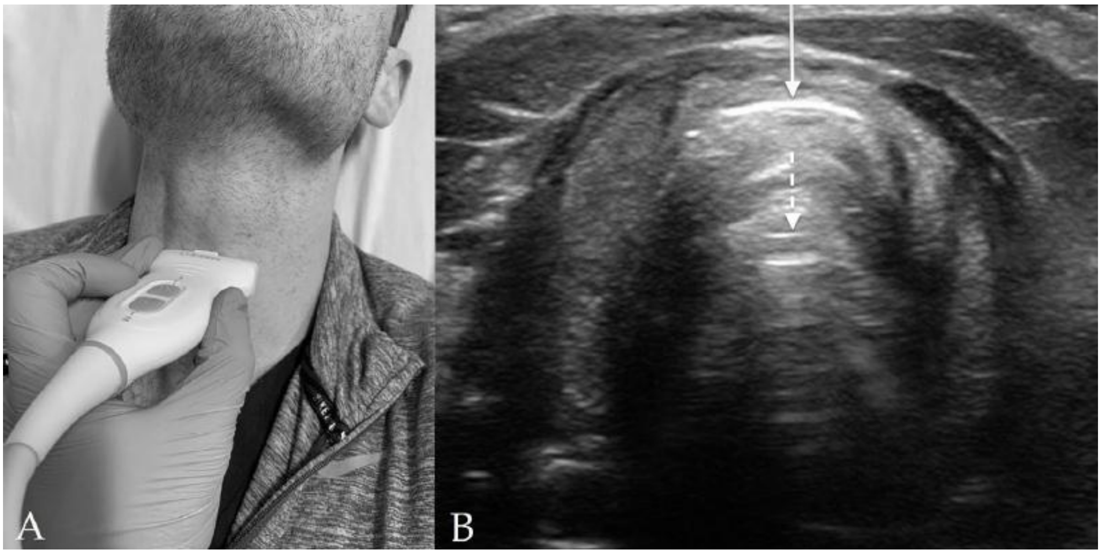


Figure 6.: A. placing probe on Cricothyroid view positioned transversely on the subject's neck. B. Anterior neck cricothyroid image using a transversely oriented linear probe. With a noticeable reverberation artifact in the tracheal lumen, the cricothyroid membrane (solid arrow) is located above the trachea.

5. **Suprasternal View**

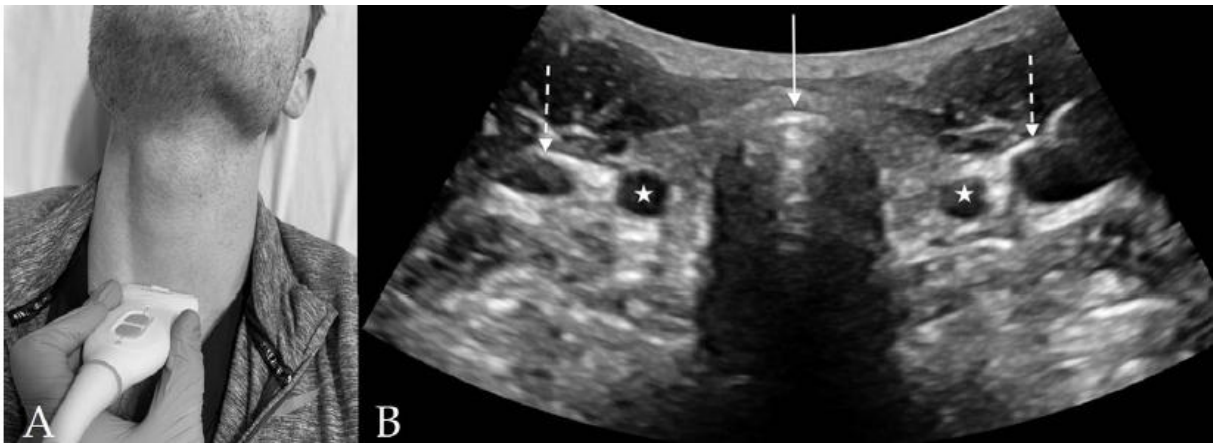


Figure 7 *:* A. Placing the probe in suprasternal view on the subject's neck.

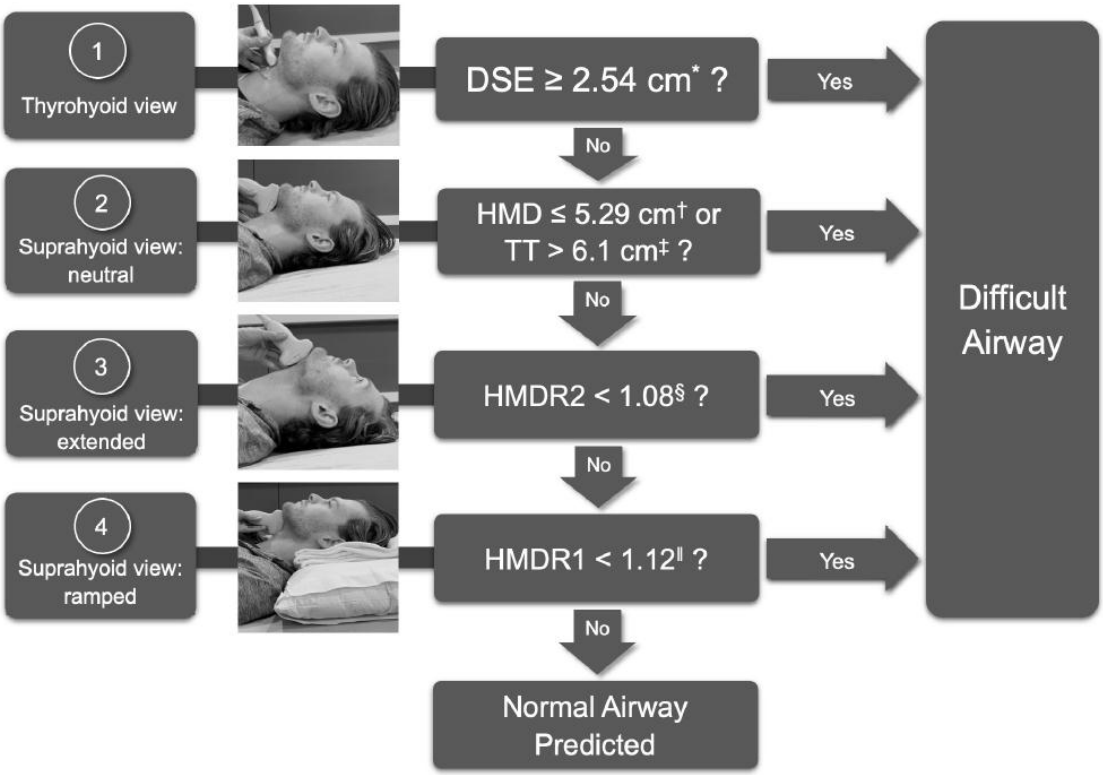
B. Anterior neck seen from above using a curvilinear probe. The air-filled tracheal lumen posteriorly exhibits reverberation artifact, giving the tracheal cartilage (solid arrow) a hyperechoic appearance. On either side of the trachea, the internal jugular veins (dashed arrow) and common carotid arteries (stars) are visible laterally.

Sonographic assessment of the Difficult Airway

Sonographic assessment of the difficult airway is a cutting-edge technique that leverages ultrasound technology to provide a non-invasive, real-time evaluation of airway structures. This approach enhances the anaesthesiologist's ability to predict and manage difficult airway scenarios, which are critical for ensuring patient safety during anesthesia and intubation. By using high-frequency linear transducers, clinicians can visualize key anatomical landmarks, such as the tongue, epiglottis, hyoid bone, and vocal cords, along with the thickness of the anterior neck soft tissue and the distance from the skin to these structures. It is possible to assess with accuracy parameters such as the location and mobility of the tongue and epiglottis, hyomental distance, and anterior neck soft tissue thickness at the level of the vocal cords.

These measurements help in anticipating potential challenges in airway management, such as difficult laryngoscopy and intubation. The ability to dynamically assess the airway in different head positions and during various phases of respiration adds a valuable dimension to preoperative planning. Despite the requirement for specialized training and experience to achieve proficiency, the advantages of sonographic airway assessment, including its safety, non-invasiveness, and objective data provision, make it a valuable adjunct to traditional airway evaluation methods. Integrating sonography into routine airway assessments can significantly improve the prediction and management of difficult airways, ultimately enhancing patient outcomes and safety in anaesthesia practice.

Figure 8 : Difficult Airway Evaluation with Sonography (DARES) Protocol



Ultra sound measurements of predictors of difficult airway

HMDR(Hyomental Distance Ratio)

The term "hyomental distance ratio," or HMDR, refers to the length of the chin at the extreme of head extension (HMDE) and the one in the neutral position (HMDN), measured from the hyoid bone. A lower occipitoatlantoaxial extension capability was first demonstrated to be predicted by HMDR, as reported by Takenaka et al. [45].

Huh and colleagues utilized HMRD as a predictor of challenging laryngeal vision. According to Huh's research, larynx vision is difficult when HMDR values are 1.2 or lower [46].

Using ultrasound to quantify HMRD, Wojtczak (2012) found a statistically significant difference in HMRD values between a group of patients with Difficult intubation and a group without Difficult intubation[47].

- **Clinical Relevance**

1. **Predicting Difficult Airway :**
2. **Correlation**: A lower HMDR is often associated with a difficult airway. Specifically, an HMDR of less than 1.2 has been found to correlate with increased difficulty in intubation.

   Significance: This ratio provides an objective, quantitative measure that can be used alongside other predictive indices to assess the likelihood of encountering a difficult airway.
3. **Assessment Tool:**

- **Non-Invasive and Simple:** Measuring the HMDR is a non-invasive, straightforward process that can be easily incorporated into preoperative evaluations.
- **Complementary Use:** It serves as a valuable adjunct to other assessments like the Mallampati score, thyromental distance, and the Cormack-Lehane classification.

❖ **Advantages**

Objective Measurement:

- **Standardization**: The HMDR provides a standardized, reproducible measure that reduces subjectivity in airway assessment.
- **Consistency**: This ratio can be consistently applied across different patient populations and clinical settings.

Ease of Use:

- **Quick Assessment**: The measurement can be quickly performed with basic clinical tools, making it practical for routine preoperative evaluation.

❖ **Limitations and Considerations**

Variability:

- **Anatomical Differences**: Individual anatomical variations can affect the HMDR, and it should be interpreted in conjunction with other clinical findings.
- **Positional Factors**: Accurate measurement requires careful positioning of the patient's head, and deviations can impact the ratio.

Training and Familiarity:

- **Operator Dependency**: The accuracy of HMDR measurements can depend on the clinician's familiarity and experience with the technique.

Pre-Epiglottic Space (PES)

The **Pre-Epiglottic Space (PES)** refers to the anatomical space located just anterior to the epiglottis. This space is important in airway management and can be relevant in the context of assessing difficult intubation or in certain pathologies affecting the airway.

Epiglottis to Mid-Point of Vocal Cord (E-VC)

The **Epiglottis to Mid-Point of Vocal Cord (E-VC)** is a measurement used in airway assessment. This distance helps in evaluating the anatomical relationship and space within the laryngeal structures, which is crucial during procedures like intubation.

Pre-Epiglottic Space to Epiglottis to Mid-Point of Vocal Cord (pre-E/E-VC) Ratio

Combining these concepts, the **Pre-Epiglottic Space to Epiglottis to Mid-Point of Vocal Cord (pre-E/E-VC) Ratio** is a measurement that could be used to assess the anatomical configuration of the airway. Here's how it might be calculated:

• Determine the Pre-Epiglottic Space's (pre-E) depth.

• Calculate the distance (E-VC) between the vocal cords' midpoint and the epiglottis.

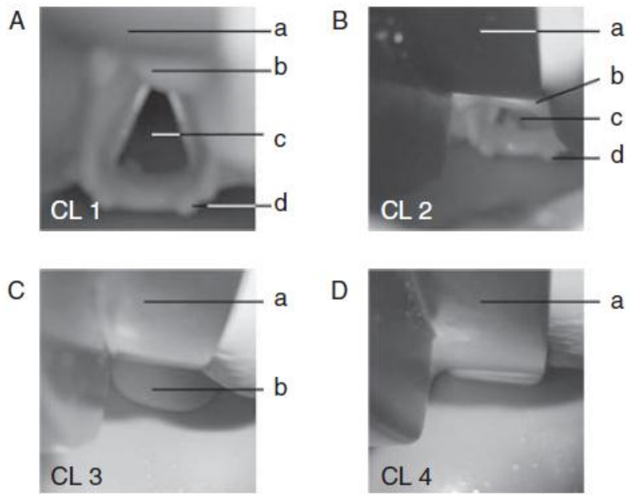
Determine the pre-E/E-VC ratio by calculating these two measurements.

This ratio could provide insight into the spatial relationships within the airway, potentially helping in the prediction of difficult intubation or in assessing airway patency and structure in various clinical scenarios.

Cormack–Lehane (CL) classification

A common grading method used to characterize the laryngeal view during direct laryngoscopy is the Cormack-Lehane (CL) classification [35]. It has established itself as the standard for airway classification in both clinical practice and research pertaining to airways since its initial publication in 1984. [36–40] Nevertheless, the CL categorization has not been completely confirmed despite being widely used. The results about inter- and intra-observer reliabilities provided by previous studies are inconclusive. [41–44] This could be due, in part, to anaesthesiologists' inadequate familiarity with the four grades, which could result in improper application. This problem may also be exacerbated by changes and inconsistent definitions and examples in the literature.

Figure 9 :Cormack–Lehane classification



a, laryngoscope blade b, epiglottis; c, glottic opening;

d, arytenoid cartilages.

Grading System

- **Grade 1:**

  Description: Full view of the glottis, including the vocal cords.

  Implications: Indicates an easy intubation with a clear view of the vocal cords.

- **Grade 2:**

  Description: Partial view of the glottis, with only the posterior commissure or arytenoids visible.

  Implications: Intubation may be slightly more challenging, but the vocal cords are still visible.

- **Grade 3:**

  Description: Only the epiglottis is visible; the vocal cords are not seen.

  Implications: Significantly more challenging intubation, as the direct view of the vocal cords is absent.

- **Grade 4:**

  Description: Neither the vocal cords nor the epiglottis is visible.

  Implications: This is the most difficult scenario for intubation, requiring advanced techniques and equipment.

De Luis-Cabezó et al. [2024][48], to ascertain if using ultrasonography to assess the upper airway might reliably forecast challenging direct laryngoscopy. This study is a prospective observational study that involved 102 adult patients who needed general anesthesia for a surgical procedure that was elective. The Arné risk index, thyromental and sternomental distances (SMD), cervical circumference (CC), Mallampati-Samsoon grade (MS), upper lip bite test (ULBT), and so on were among the information gathered. Five distinct levels and two planes—the parasagittal and transverse—were used to evaluate the ultrasound.

As a result, the following measurements were made and recorded: the separation between the skin and the hyoid bone (DSHB), the separation between the skin and the thyrohyoid membrane (DSTHM), the' distance between the skin and the epiglottis' (DSE), the separation between the' skin and the thyroid cartilage' (DSTC), and the separation between the two (DHBTC). Patients were classified using the Cormack-Lehane (C-L) system depending on how difficult it was to perform direct laryngoscopy. Gender (2 points for men), DSTHM (1.60 cm; 2 points), and DSTC (0.78 cm; 3 points). The AUC (95% CI) was 0.84 (0.74–0.95), and the score can be between 0 and 7. A 'sensitivity of 91.67, specificity of 75.56, positive predictive value of 33.33, negative predictive value of 98.55', and a 34-fold increase in the probability of detecting DL (p D 0.0010) are associated with a score of 5 points or above.

According to the study's findings, ultrasonography and traditional clinical screening tests can be used as helpful tools to forecast challenging direct laryngoscopy procedures.

Under general anesthesia, **Chhabra et al.[2023]**[49] investigated the correlation between the Cormack-Lehane (CL) grade at direct laryngoscopy view and the pre-anesthetic ultrasonographic (USG) airway assessment parameters. It was shown that the incidence of difficult laryngoscopy was 22.7% in this observational research of 150 adult patients, ages 18 to 70, who were included for general anaesthesia for elective surgery. With a sensitivity of 64.71% and specificity of 78.45% ($p = 0.000$), The anterior neck surface to epiglottis sonographic distance (ANS-E)/Pre-Epiglottis space > 1.67 cm was discovered to be a statistically significant USG predictor of a challenging laryngoscopic view. The sonographic distance between the anterior neck surface and the anterior commissure (ANS-AC) or hyoid bone (ANS-H) did not correlate with difficult laryngoscopy.

Positive predictive value was lower for the ultrasonography (US) parameters than negative predictive value. They also found that USG is a helpful technique for identifying people who are "at-risk" for having problematic airways.

In order to compare and correlate the airway assessment performed clinically and the airway viewed ultrasonographically with the Cormack-Lehane classification of the direct laryngoscopy, **Ankad et al. [2023]**[50] studied the usefulness of ultrasonography in assessing difficult airway preoperatively. In this observational trial, there are 150 patients undergoing elective surgeries under general anesthesia. Based on the Cormack-Lehane categorization of laryngoscopic view, patients were divided into two groups at the end of the trial: group A, which involved easy intubation, and group B, which involved difficult intubation.

In study it was found that group B outperformed group A in ultrasound measures of the airway at four different levels: the hyoid bone, suprasternal notch, thyroid isthmus, and thyroid. The p-values for these measurements were 0.0002, 0.0001, 0.001, and 0.0001, respectively, indicating statistically significant findings.

According to the study's findings, ultrasound can be used to evaluate problematic airways before to surgery by evaluating the thickness of the soft tissues in the anterior region of the neck.

In a study conducted by **Chhavi Goel et al.[2023]**[51], the Ultrasonography indices were evaluated for their ability to predict airway issues in obese patients and their correlation with clinical indicators. The eight ultrasound parameters included in this study were 'skin-to-hyoid distance, tongue thickness, skin-to-midpoint of vocal cords, pre-epiglottic space, skin-to-thyroid isthmus, hyomental distance, anterior soft tissue thickness at the suprasternal notch, and thyromental distance'. These parameters were linked to clinical assessment (Cormack-Lehane grading).

Out of the 40 cases that were reviewed, 29 (72.5%) were anticipated to be difficult during an ultrasonography that looked at the airways, and 19 (47.5%) were found to be difficult during a clinical intubation. Five parameters in total were clinically correlated: hyomental distance (sensitivity 65.7%, specificity 61.5%, cut off value 7.24 cm), anterior soft tissue thickness (sensitivity 88.7%, specificity 60.3%, cut off value 1.23 cm), skin to midpoint of vocal cords (sensitivity 89.6%, specificity 60.3%, cut off value 1.46 cm), pre-epiglottic space (sensitivity 77%, specificity 74.2%, cut off value 0.56 cm), and thyromental distance (sensitivity 80%, specificity 61.4%, cut off value 7.2 cm).

The predictive power of clinical and sonography-based airway assessment factors for challenging laryngoscopy and intubation was investigated by **Anushaprasath et al. [2023][52] .** The study comprised 130 patients between the ages of 18 and 60 who were having an elective intubation. It found that the prevalence of difficult laryngoscopy and difficult intubation was 17.6% and 11.5%, respectively. The difficult laryngoscopy was significantly correlated with 'Mallampati grade (MMG), upper lip bite test (ULBT), neck circumference, hyomental distance ratio (HMDR), tongue thickness (TT), skin to epiglottis/epiglottis to vocal cord distance (SED/E VC), and mandibular condylar mobility (MCM)'. The difficult intubation was significantly correlated with MMG, neck circumference, SED, and SED/E VC. When these variables were combined, they demonstrated improved diagnostic performance for challenging airways. 'Area under the curve (AUC) for model 1 based on ultrasound parameters was 0.848 (CI 0.748 0.947, P value < 0.0001), while for model 2 based on clinical and ultrasound parameters combined, the AUC was 0.755 (95% CI 0.631 0.879, P value < 0.0001)’.

An extensive review of the available data on the application of ultrasonography in airway management was conducted by **Lin, J. et al. [2023]** [53] in order to pinpoint areas that warrant further investigation. According to the study's findings, ultrasonography is a safe and effective technique for managing problematic airways, but doctors should also be ready to use additional rescue airway procedures like video-laryngoscopy or bag-valve-mask ventilation.

In order to determine whether preoperative sonographic airway evaluation parameters and the Cormack-Lehane (CL) grading at laryngoscopic view are correlated, **Harjaiet al.[2023]** [54] conducted research on patients having general anesthesia with endotracheal intubation.150 patients underwent elective surgery while under general anesthesia. 13.3% of cases involved difficult intubation. The Mallampati Grading (MPG), with 86.7% sensitivity, had the highest receiver operating characteristic (ROC) and area under the curve (AUC) of all the clinical predictors. In addition, the skin-to-thyroid isthmus distance has the highest sensitivity for predicting challenging laryngoscopy, and the skin-to-hyoid distance has the highest ROC of all the sonographic measures. A difficult laryngoscopy can be detected by MPG and sonographic characteristics such the separation between the skin and the thyroid isthmus and the skin and the hyoid.

In order to forecast problematic airways, **Yadav et al.[2023] [55]** compared the clinical and ultrasonography guided airway assessment methods. The study included 200 patients who met the Cormack-Lehane laryngoscopic criteria, which classified laryngoscopy as easy (grades 1 and 2) or difficult (grades 3 and 4). Of the 200 patients, 168 patients (84%) had a simple laryngoscopy, while 32 patients (16%) had a tough one. All the predictors of difficult intubation that were employed in this study produced accurate predictions ($P < 0.05$). The accuracy measures were as follows: 'skin-to-vocal cords (91%), thyromental distance (80.81%), mallampati grade (78%), interincisor distance (17%), hyomental distance (76%), and tongue breadth (73%)'.

The study found that skin-to-vocal cord distance, a sonographic criterion, had the highest accuracy when compared to the other criteria, however both clinical and ultrasound parameters could indicate difficult intubation.

In order to determine if preoperative airway ultrasound might predict difficult direct laryngoscopy in adult patients undergoing elective surgery under general anaesthesia, **Andrea Carsetti et al**. [2022][56] did a meta-analysis. For the quantitative examination of summary receiver operating characteristic (SROC), fifteen research have been taken into consideration. The sensitivity values were 0.82 (0.74–0.87), 0.71 (0.58–0.82), and 0.75 (0.62–0.84) for the distances from the skin to the vocal cords (DSVC), the hyoid bone (DSHB), and the epiglottis (DSE), respectively. For DSE, DSHB, and DSVC, the corresponding specificities were 0.79 (0.70–0.87), 0.71 (0.57–0.82), and 0.72 (0.45–0.89).

The pre-epiglottic space depth and the distance between the vocal cords and the epiglottis (Pre-E/E-VC) ratio had area under the curves (AUCs) of 0.87 (0.84–0.90), 0.77 (0.73–0.81), 0.78 (0.74–0.81), and 0.71 (0.67–0.75), respectively, for DSE, DSHB, DSVC, and DSVC. DSE, DSVC, and DSHB values are higher in patients who had difficult direct laryngoscopy than in those who had easy laryngoscopy; the mean differences are ‘0.38 cm (95% confidence interval [CI],’ 0.17–0.58 cm; P =.0004), 0.18 cm (95% CI, 0.01–0.35 cm; P =.04), and 0.23 cm’ (95% CI, 0.08–0.39 cm; P =.004), in that order’.

In order to discover ultrasonography characteristics as predictors of difficult airway in patients undergoing surgery under general anesthesia, **Sharma M et al.[2022]**[57] conducted a study. 99 patients in a row with general anesthesia and endotracheal intubation scheduled for elective surgery. According to the study, 23 (23.2%) people experienced difficult intubation as CL grade 3. The writers were not exposed to CL grade 4. The results show a considerable correlation between CL grading and HMDR and PreE/EVC, with ‘specificities of 71% and 77%, respectively, and strong negative predictive values of 84.3% and 84.2%, respectively’.

As such, it is useful in anticipating challenging intubations. The ANS-VC did not show any discernible relationship. The study concluded that PreE/E-VC and HMDR improve the diagnostic prediction of problematic airways.

Materials and Method

Study Design :

Double-blind prospective observational study.

Source of data:

This study was carriedin the Department of Anaesthesiology, B.LD.E's (Deemed to be University) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapur.

Study Duration and Place of Study :

The study was conducted from Dec 2022 to March 2024.

Study Population

This study was carried amongst patients between 20 to 60 years of age of either sex admitted for elective surgery under general anaesthesia

Sample Size :

With anticipated Proportion of Predicting difficult intubation in all elective surgeries under GA is 12.5% the study would require a sample size of 174 patients with a 95% level of confidence and 5% absolute

Formula used is $z = Z^2PQ/ME^2$

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients aged between 20-60 years.
- Patients admitted for elective surgeries under General Anesthesia requiring direct laryngoscopy and endotracheal intubation with ASA Grade I & II.

Exclusion Criteria

- Inability to consent for the procedure
- Patients with inter incisor gap <3cm, edentulous patients
- Patients with head and neck pathologies
- Patients have altered sensorium and inability to follow commands

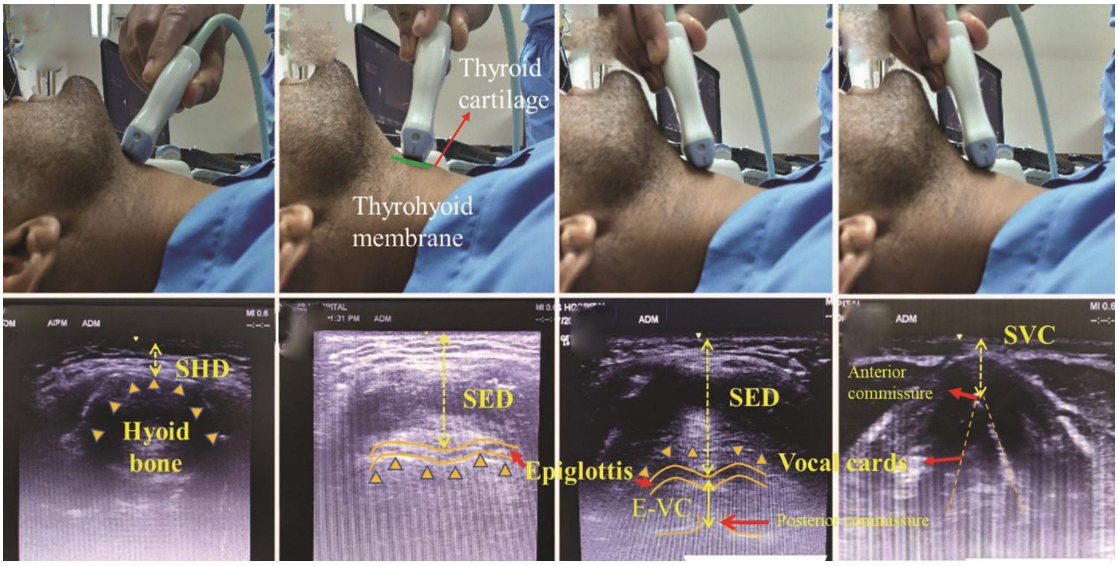
Ethical Committee Approval:

The present study was approved by institutional ethics committee of our tertiary care centre (B.L.D.E.U.'s) committee.

Methodology:

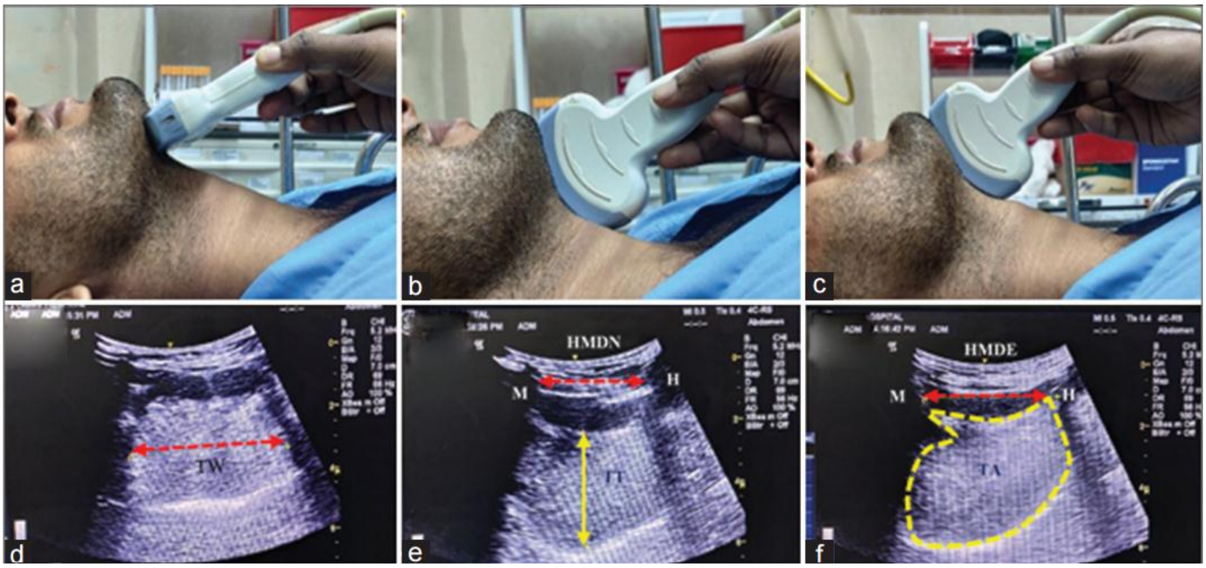
Two predictive ratios were done during the preoperative examination; they are the depth of the pre-epiglottic space (Pre-E) to the distance from the epiglottis to the mid-point of the distance between the vocal cords (E-VC), i.e., pre-E/E-VC ratio and hyomental distance ratio (HMDR) in predicting difficult airway.

Pre-E/E-VC: True vocal cords appear as a triangular, hypoechoic structure with vocal ligaments that are hyperechoic at their medial border. The anterior meeting of the vocal cords is known as the anterior commissure. At the submandibular area, the high-frequency linear probe was put midline. At the submandibular region, the high-frequency linear probe was positioned midline. Without changing the probe's direction, the linear array of the US probe was rotated from cephalad to caudal in the transverse plane until the epiglottis, and posterior vocal folds with arytenoids were visible on the screen at the same time. In the oblique transverse view, the epiglottis is visible as a hypoechoic curvilinear structure through the thyrohyoid membrane. The hyperechoic Pre epiglottic space and its posterior boundary, as well as a vivid linear mucosal air interface, defined the anterior boundary.



Pre-E and E-VC were both measured, and the ratio was computed.

HMDR: A standard curvilinear probe placed in the mid-sagittal plane in the submandibular region. HMDR echo will be obtained from the ratio of the hyomental distance with the head placed in the maximal hyperextended position and the hyomental distance measured with the head in the neutral position. The hyomental distance is measured between the anterior border of the hyoid bone and the posterior aspect of the symphysis menti. The ultrasound measurements were performed the day before surgery and anaesthesia with a curvilinear ultrasound transducer.



Cormack-Lehane`s scale;

Grade 1-vocal cords visible.

Grade 2-only posterior commissure or arytenoids visible.

Grade 3-only epiglottis visible.

Grade 4-none of the above is visible.

Intubation was considered difficult if;

- The view on laryngoscopy was Cormack and Lehane grade III or IV.
- Three attempts at tracheal intubation.
- Duration longer than 10 minutes.
- Failure to intubate or if special manoeuvres are required to facilitate intubation.

Cormack and Lehane view grades 3 and 4 were deemed to be difficult airway.

Easy visualization was described as grade 1 and 2 of the Cormack and Lehane classification. Confirmation of intubation was done by bilateral auscultation of lung fields and capnography.

Statistical Analysis

Data were collected in the Microsoft Excel 2020 for further statistical analysis, categorical data were expressed in terms of frequency and proportion whereas quantitative data were expressed in terms of mean and standard deviation. T-test were used to find mean difference between two variables and chi-square test were used to find out association between two or more variables. Recover operating curve (ROC) was used to find out cut off values of predictor parameter of difficult laryngoscope. P-value<0.05 were considered as statistically significant.

Observation and Results

Table1: Age distribution among study population

Age interval	Frequency	Percent
20-30 Years	31	18
30 - 40 Years	32	18.2
41 - 50 Years	58	33.3
51 - 60 Years	53	30.5
Total	174	100

Age distribution among study population shown in above table, it was observed that majority of the patients were lying in the age group of 41 – 50 years of age followed by 51-60 years and 30-40 years of age.

Figure1: Age distribution among study population

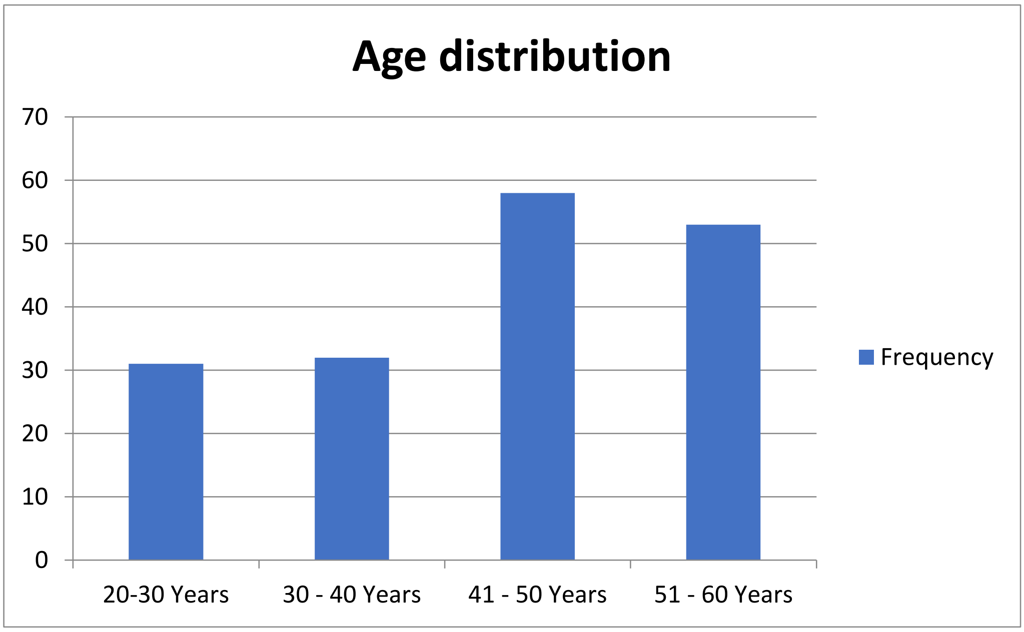


Table 2: Gender distribution among study population

Sex	Frequency	Percent
Male	99	43.1
Female	75	56.9
Total	174	100

There were more numbers of males present in the study compared to females as shown in above table.

Figure2 :Gender distribution among study population

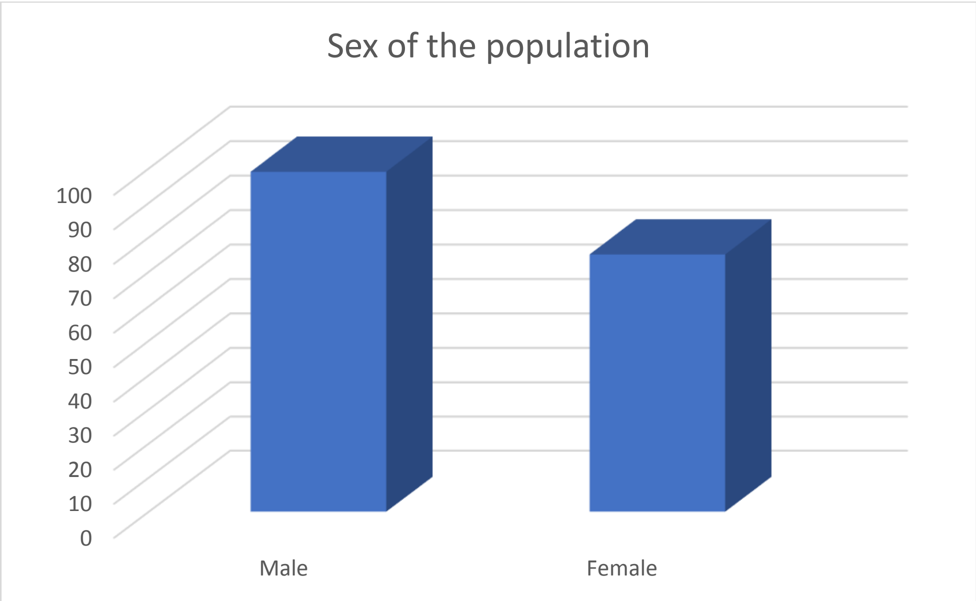


Table 3: Mean distribution of demographic profile among study population

Parameter	Group		t-test	p-value
	Easy Laryngoscopy (n=143)	Difficult Laryngoscopy (n=31)		
Age	44.45±8.30	45.6±8.54	1.27	0.102
Weight	60.16±5.91	60.7±5.88	-0.29	0.386
Height	158.6±3.06	159.02±2.51	-2.483	0.623
BMI	23.47±2.48	23.95±2.47	0.343	0.365

Mean age, weight and height distribution between easy and difficult laryngoscopy were statistically not significant, they were comparable between the groups.

Figure 3: Mean distribution of demographic profile among study population

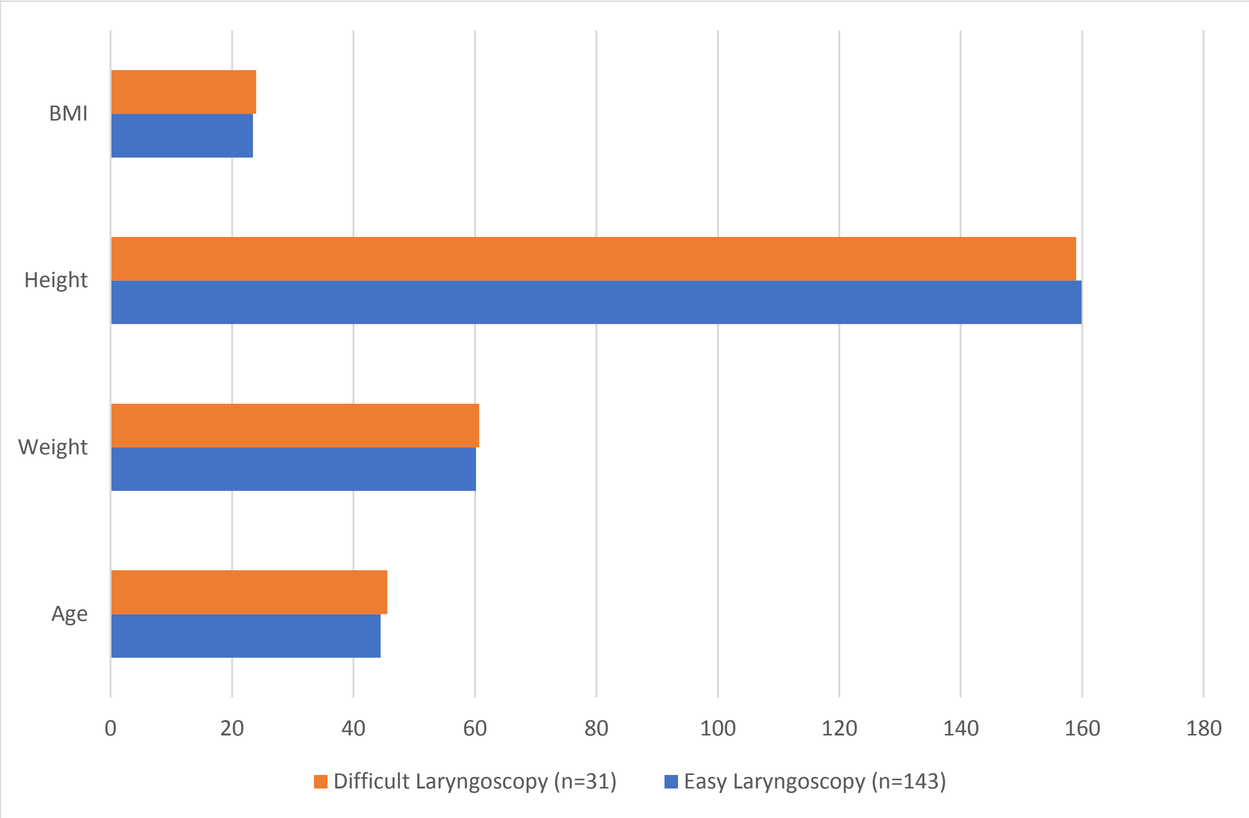


Table4: Mean distribution of HMDN, HMDE and HMDR among study population

HMD	Group		t-test	p-value
	Easy Laryngoscopy (n=143)	Difficult Laryngoscopy (n=31)		
HMDN(cm)	4.15±0.35	4.36±0.38	23.532	<0.001
HMDE(cm)	5.38±0.45	5.04±0.47	34.256	<0.001
HMDR(cm)	1.30±0.05	1.16±0.05	17.609	<0.001

Mean of (HMD) Hyomental distance between the easy and difficult groups at neutral position (HMDN) was clinically and statistically highly significant, also in extended position(HMDE) it was clinically and statistically highly significant in between easy and difficult laryngoscopy groups and the ration of HMDN and HMDE (HMDR) was also clinically and statistically highly significant as shown in above table.

Figure 4:Mean distribution of HMDN, HMDE and HMDR among study population

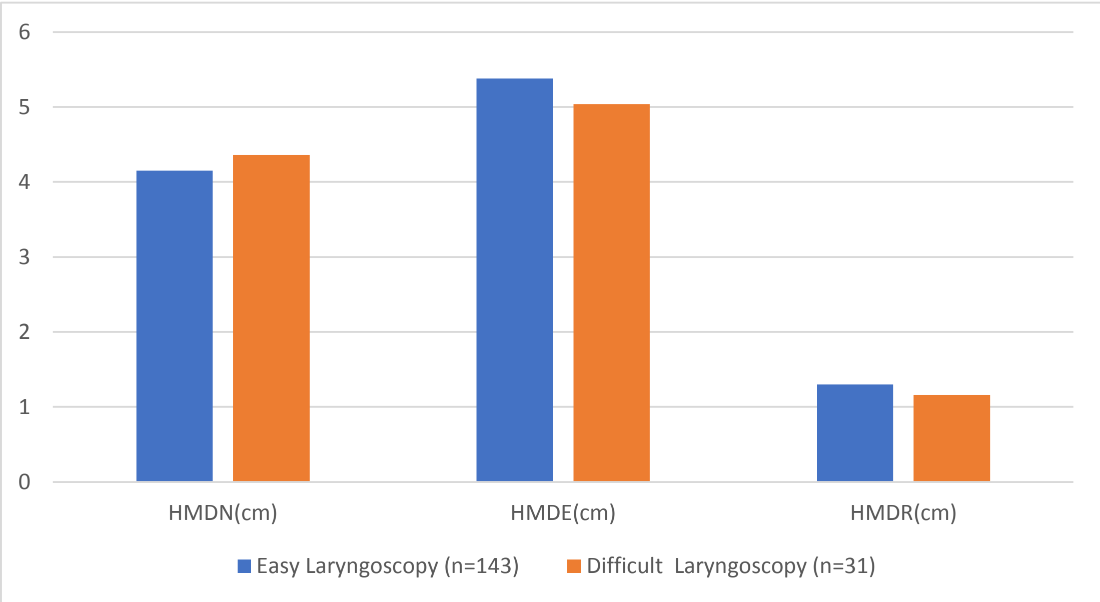


Table 5: ROC to find HMDR cut off value to predict difficult airway

HMDR	
ROC Parameter	Values
Area Under Curve	0.699
Standard Error	0.004
p-value	<0.001
Sensitivity	70%
Specificity	85%
Cut off Value	1.14

The cut-off value of HMDR to predict a difficult airway was 1.14, with a sensitivity of 70% and a specificity of 85 %, and it's statistically highly significant, which was shown in the figure 6.

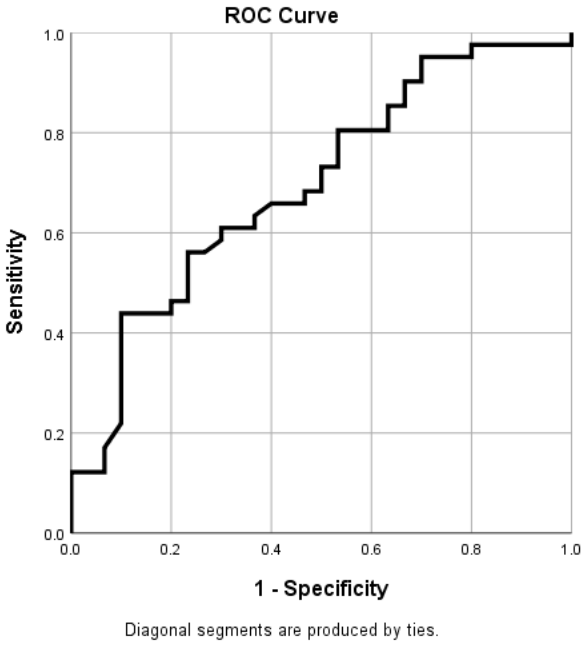


Table6 :Mean distribution of Pre E, E-VC and Pre E/ E-VCamong study population

Parameter	Group		t-test	p-value
	Easy Laryngoscopy (n=143)	Difficult Laryngoscopy (n=31)		
Pre E(mm)	1.80±0.46	2.23±0.19	7.56	<0.001
E-VC(mm)	1.51±0.46	1.15±0.16	9.023	<0.001
Pre E/E-VC	1.25±0.38	1.95±0.20	4.646	<0.001

Mean Pre-E values between the easy and difficult groups were statistically highly significant, also mean E-VC was statistically highly significant, and the ratio of pre-E and E-VC(Pre E/E-VC) was also statistically highly significant, as shown in the above table.

Figure 6: Mean distribution of Pre-E, E-VC and Pre E/ E-VCamong study population

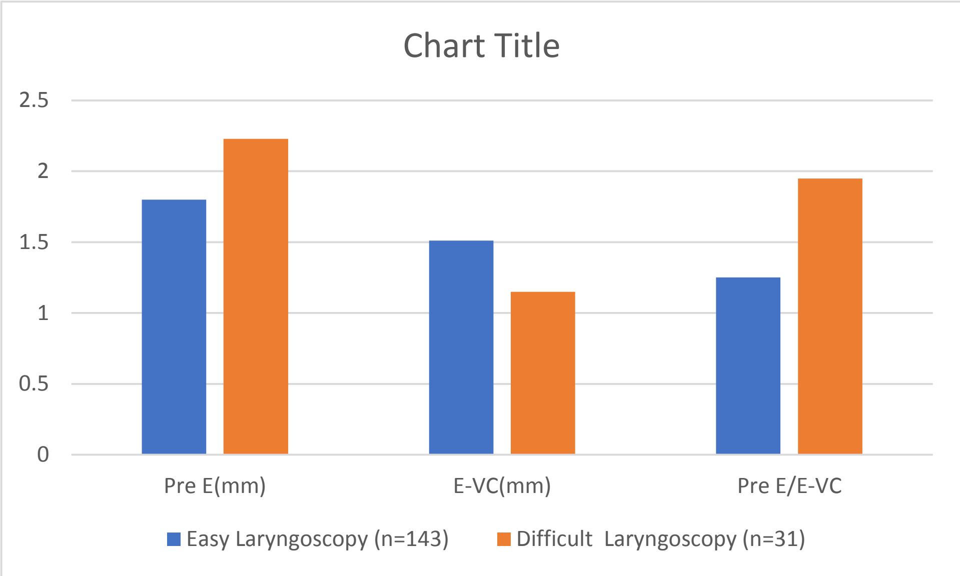
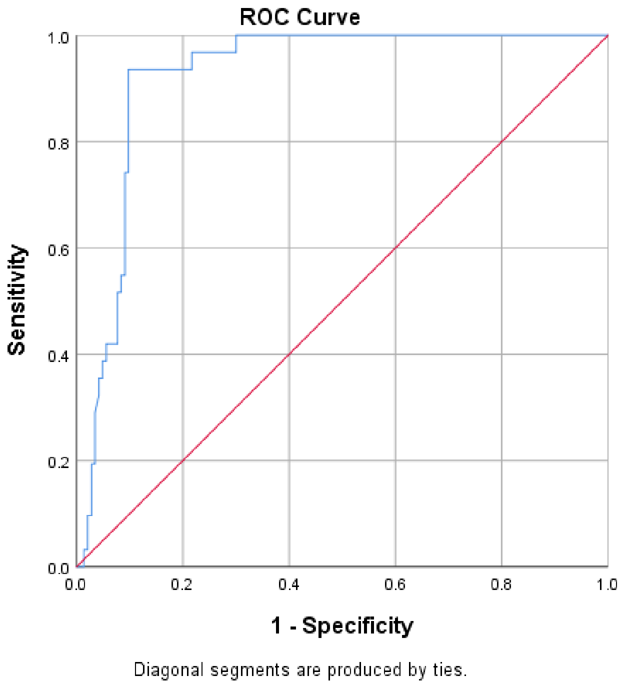


Table7 :ROC to find Pre E/E-VC cut off value to predict difficult airway

Pre E/E-VC	
ROC Parameter	Values
Area Under Curve	0.923
Standard Error	0.063
p-value	<0.001
Sensitivity	92%
Specificity	85%
Cut off Value	1.90



According to the above figure 7, ROC curve AUC was 0.923and the Pre E/E-VC cut-off value for predicting a difficult airway was 1.90, with a sensitivity of 92%% and a specificity of 85% (P value <0.001which was highly significant)

Table 8: CL Grading distribution among study population

CL Grading	Frequency	Percent
Grade 1	79	45.8
Grade 2	64	36.4
Grade 3	20	11.4
Grade 4	11	6.4
Total	174	100

It was observed that, there were majority of the patients were from grade 1 of CL grading, followed by grade 2, grade 3 and Grade 4 as shown in table number 8.

Figure 8: CL Grading distribution among study population

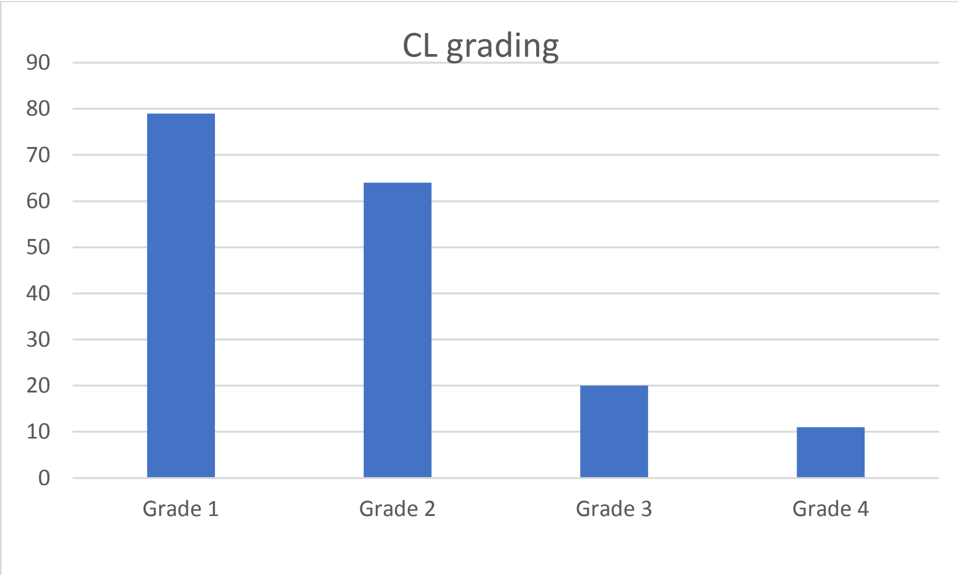


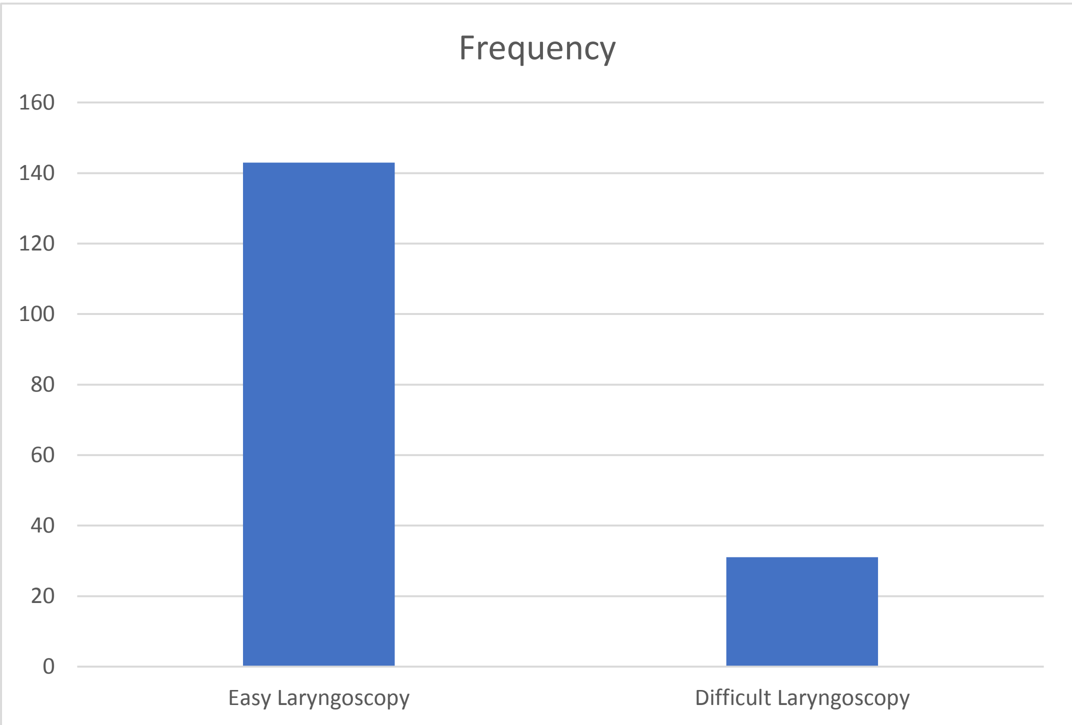
Table 9: Airways distribution among study population

Airways	Frequency	Percent
Easy Laryngoscopy	143	82.2
Difficult Laryngoscopy	31	17.8
Total	174	100

It was observed that, 17.8% of the patients were with difficult laryngoscopy and 82.2% of the patients were with easy laryngoscopy as shown in above table.

The incidence of the difficult airway in this study was 17.8% which was shown in table 9.

Figure 9: Airways distribution among study population.



Discussion

One of the most important aspects of anesthesia management is anticipating problematic airways. Numerous investigations have been carried out with the objective of ascertaining the function of upper airway ultrasonography (UA-US) in forecasting the degree of difficulty associated with direct laryngoscopy, in individuals without evident signs of difficulties during routine clinical assessment. ‘During the pre-aesthetic evaluation, a number of conventional and non-invasive screening parameters, such as "mouth opening, modified Mallampati classification, jaw protrusion, thyromental distance (TMD), and the upper lip bite test," are available for airway assessment’. However, even with this, much work has been done on these parameters; their authenticity in predicting direct laryngoscopy while tested alone or in combination is questionable due to their low accuracy [58]. ‘In order to more accurately anticipate the problematic airway during the pre-aesthetic evaluation, a non-invasive bedside screening test should be prioritized’.

In the last few years, the inclusion of ultrasound in anaesthesiologist’s arsenal has revolutionized perioperative care, including pre-anaesthetic assessment; however, few studies have employed ultrasonography-directed predictors to measure the airway during the preoperative period and shown encouraging results [59-60]. Thus, **(**the goal of the current study was to analyse preoperative sonographic parameters to predict the degree of difficulty at direct laryngoscopy and notify us when it is time to prepare for a difficult airway management setup, such as video laryngoscopy, fibreoptic scope, and surgical airway management.

This study includes 174 adult patients posted for elective surgeries under general anaesthesia among them 31 patients had difficult laryngoscopy. The incidence of difficult airway was found to be 17.8% which was CL grade 3,4

One clinical criterion of interest during the pre-anesthetic evaluation is HMD, and using it has the benefit of being simple. The ability to achieve neck hyperextension is reflected in the expansion of the submandibular space, as the hyoid bone position advances parallel to the cervical spine during maximal head extension'.

HMDR reflects the occipito-atlantoaxial complex extension capacity [61]. HMDR has been used to estimate the size of the submandibular space [62]. While the submandibular space extends during laryngoscopy, this parameter—which may appear static from this perspective—is actually dynamic.

In the present study we observed that HMDR had a with CL grading with an area under the curve (AUC) of 0.693 and regression coefficient of − 0.384 (95% CI : -0.8566 to -0.686; $P = 0.00$). 'The cutoff value of HMDR for predicting difficult laryngoscopy was found to be ≤1.14 with a sensitivity of 70% and specificity of 85%(P value <0.01) using receiver operating curves and Youden's index.

The elasticity in the sagittal plane might reflect the submandibular space compliance, as described by Greenland et al [63].The HMDR discriminative cutoff was first determined in a clinical study conducted by Huh et al., who identified an optimal threshold of 1.2 as providing the optimal accuracy a sensitivity of 88% and specificity of 60% [61]. Even though the approach was the same, subsequent clinical trials that used the same cutoff revealed significant differences in terms of sensitivity and specificity, depending on the populations covered. High sensitivity has been shown in certain studies, which is noteworthy for challenging airway investigations because false negatives might have disastrous consequences.

Good sensitivity and specificity values were found by some authors 88% sensitivity and 69.2% specificity in non-obese patients [64,65]. Other studies confirmed moderate sensitivity of around 60% and lower specificity, suggesting that HMDR has little utility for difficult airway prediction [66,67]. A low sensitivity of 27.78% has also been reported for HMDR clin [68].

Imaging techniques may be helpful because clinical studies vary widely and there are no reliable clinical diagnostics to predict problematic airways.

Computed tomography, magnetic resonance imaging, and plain radiography have all been investigated [69]. Ultrasound is comparable to these, but is a cheaper, faster, non-irradiating, and non-invasive technique [70]. The sonographic assessment of the airway has encouraging results in predicting difficult laryngoscopy [71]. Ultrasound examination of the HMDR may be of interest because of the broad diversity in clinical trials, particularly given the ease of the scanning approach.

With a cutoff of 1.24, the sensitivity of ultrasound-measured HMDR was 86–100%, while the specificity was 72–90.5% in the non-obese and obese populations [72,73]. Using ROC analysis, **Koundal et al**. found a cutoff of 1.08–1.085 for HMDR echo, with 75% sensitivity and 85% specificity [74]. However, a low sensitivity of 42.9% has also been reported, leading to the conclusion that these individual sonographic parameters, among others, have unsatisfactory diagnostic profiles [75].

Furthermore, there are still instances of neck anatomical structure palpation issues in individuals who do not have morbid obesity, which may account for the weak correlation between the two studied measures.

'The vocal cords with arytenoid were hyperechoic "V" shaped structure. The Pre-E and E-VC were measured. Then the ratio of Pre-E/E-VC was calculated. The ratio of the depth of PreE and E-VC, the PreE/E-VC has also been shown to be quite effective in detecting difficult airways'. Most of the studies have concluded that a higher mean Pre-E/E-VC is recorded in difficult airway[76-79].

Mean Pre-E values between the easy and difficult groups were statistically highly significant, the mean E-VC was statistically highly significant, and the ratio of pre-E and E-VC was also statistically highly significant. The cut-off value of Pre-E/E-VC to predict difficult airway was 1.90, with a sensitivity of 92% and a specificity of 85% (p value<0.01), and it is statistically highly significant.

Demographic Profile and distribution of CL Grading

In Present study we have undertaken to compare the ultrasound-guided airway parameters HMDR and Pre E/E-VC ratio as predictors of difficult laryngoscopy (Cormack–Lehane Classification 3, 4). In the present study, we have included a total of 174 patients aged 20 to 60 years of either sex admitted for elective surgery under general anesthesia. We have observed that, in the present study, majority of the patients were lying in the age group of 41 – 50 years of age followed by 51-60 years of age, more numbers of males present in the study compared to females and majority of the patients were from grade 1 of CL grading, followed by grade 2, grade 3 and Grade 4. We have observed that, 17.8% of the patients were with difficult laryngoscopy and 82.2% of the patients were with easy laryngoscopy. A study conducted by **Yadav et al**., the mean age was 35.76 years, with the majority being females (51%).'Of the 200 patients, 32 (16%) were classified as having a difficult laryngoscopy, while 168 (84%) were classified as having an easy laryngoscopy.

Another study by **Harjai et al.** The ages of the '150 adult patients ranged from 18 to 65, with 64 men (42.7%) and 86 women (57.3%). Compare 13.3% of laryngoscopies (20 patients) were difficult, their study involved the measurement of clinical airway assessment preoperatively based on certain parameters (inter incisor gap (IIG), modified Mallampati grading (MPG), neck circumference/thyromental distance (NC/TMD), ratio of height to thyromental distance (RHTMD)) and corelate to CL grading to predict difficult laryngoscopy, while 86.7% of laryngoscopies (130 patients) were easy. The distribution of patients by CL grade at direct laryngoscopy revealed 53 patients with CL Grade II (35.3%) and 77 patients with CL Grade I (51.3%). Comparatively, none of the patients had CL Grade IV, while 20 patients (13.3%) had CL Grade III'.

Sharma M et al. included 99 patients, 30 (30.3%) of whom were men and 69 (69.7%) of whom were women. The age range covered by this group was 18 to 65. Twenty-nine (29.3%) had CL grade 1, forty-seven (47.5%) had CL grade 2, and twenty-three (23.2%) had CL grade 3(P-value <0.01). There were no CL grade 4s encountered by the writers. According to **Anushaprasath et al**., 23 out of 130 cases (17.7%) had a difficult laryngoscopy (CL grades 3 and 4). An additional study conducted by **Rana et al**. 'found that 40 patients (33%) had CL Grade 1, 65 patients had CL Grade 2 (54%), 10 patients had CL Grade 3 (8.1%), and 5 patients had CL Grade 4. As a result, 87.5% of laryngoscopies were simple and 12.5% were challenging'.

❖ Hyomental Distance Ratio predicting difficult airways

The mean hyomental distance between the groups at the neutral position (HMDN) was statistically highly significant, also in the extended position (HMDE) it was statistically highly significant and the ratio of HMDN and HMDE in easy and difficult laryngoscopy groups (1.30±0.05 vs 1.16±0.05) was also statistically highly significant, and in the present study Cut off the value of HMDR to predict difficult airway was 1.14, with a sensitivity of 70% with the specificity 85%, and its statistically highly significant.

A study was done by **Sharma M et al.** [77]**,** studied that, 'the HMDR in their study has been found to have a significant correlation with CL grading with a cut-off of <1.18 with higher CL grade, with a sensitivity of 56.52% and specificity of 71.05%, negative predictive value of 84.37% and accuracy of 67.6%(P-value =0.01). Also, a recent meta-analysis has quoted that the mean difference of HMDR was 0.07 cm lower in difficult than easy airways, which was significant. The cut off value of 1.08 has been calculated by studies, with sensitivity of 75% and specificity of 85%.[77] 'The HMDR can serve as an important aspect of ultrasound parameters for difficult airway, even for obese and morbid obese patients had an HMDR of 1-1.05

According to one more study by **Anusha Prasath et al.** , the hyomental distance ratio tells about reduced occipitoatlantoaxial extension in addition to being a more descriptive and better predictor of difficult visualization of the larynx[86]. 'They noted a statistically significant difference in the hyomental distance ratio between the easy and difficult laryngoscopy groups, The cut-off value of HMDR >0.846 had good sensitivity of 82.61% and a negative predictive value of 91.8%; poor specificity of 42.06% and a positive predictive value of 23.5% in predicting difficult laryngoscopy (AUC-0.631; *P* value- *0.0273)'*. **Huh J *et al*.,**[87]in their study, found that the HMDR cut-off point of 1.2 had a sensitivity of 88% and a specificity of 60% for predicting difficult laryngoscopy. **Rana et al.** [77] observed that the HMDR had a strong negative correlation with CL grading with an area under the curve (AUC) of 0.871 and regression coefficient of −0.466 (95% CI : -0.956 to -0.786; *P* = 0.00). 'The cutoff value of HMDR for predicting difficult laryngoscopy was found to be ≤1.0850 with a sensitivity of 75% and specificity of 85.3% using receiver operating curves and Youden's index.

Pre E, E-VC and Pre E/ E-VC

In the present study the Mean Pre-E values between the easy (CL grading 1,2) and difficult groups (CLgrading 3,4) was statistically highly significant, the mean E-VC was statistically highly significant, and the ratio of pre-E and E-VC between easy and difficult groups (1.25±0.38 cm vs 1.95±0.20cm) which was also statistically highly significant. The cut-off value of Pre-E/E-VC to predict difficult airway was 1.90, with a sensitivity of 92% and a specificity of 85% (p value<0.01), and it was statistically highly significant.

The PreE/E-VC has also been demonstrated to be extremely useful in identifying challenging airways, based on the ratio of depth of PreE and E-VC, as reported by **Sharma M et al.** 'Most of the studies have concluded that a higher mean PreE/EVC is recorded in difficult airway.[77] In their study, an 'AUC of 0.59 with a cut-off value of 1.77 with a specificity of 77.6% and negative predictive value of 84.2%', with sensitivity and specificity of 80.2% and 80% respectively (P-value =0.01).[77]

Another study conducted by **Koundal et al**[74] had a cut-off of 1.87 with sensitivity and specificity of 82% and 83% (P-value <0.01). This supports current study results with cut off value of 1.90. Some studies with different results were conducted by **Reddy et al.** [80]**;** the value of PreE/E-VC for difficult airway was 1.29 ± 0.44, with an unknown cut-off value. Likewise

According to the **Rana, et al**[77] regarding the utilization of sonographic guided Pre E/E‑ VC ratio to CL classification, the values of Pre E/E‑ VC ratio were (mean ± SD: 1.33 ± 0.335 and 1.62 ± 0.264) for CL Grade 1, 2, respectively, and 1.87 ± 0.243, 2.22 ± 0.29 corresponded to CL Grade 3 and 4 (*P* = 0.00). The mean Pre-E/E-VC values in the Reddy et al. study was 1.09 ± 0.38 for CL Grades 1 and 2, 1.28 ± 0.37 for CL Grade 3, and 1.29 ± 0.44 for CL Grade 3. Nevertheless, the authors did not come across a patient with CL 4 during the investigation. In present study values of Pre-E and E-VC ratio were (mean ± SD: 1.25±0.38 vs 1.95±0.20) for easy and difficult laryngoscopy groups.

In the present study we observed that Pre-E/E-VC had a strong positive correlation with CL grading with an area under the curve (AUC) of 0.923 'The cutoff value for predicting difficult laryngoscopy is found to be >1.90 with a sensitivity of 92% and specificity of 85%(P value <0.01) using receiver operating curves and Youden's index.

Out of 174 patients 31 patients had difficult airway. These patients were managed by using the BURP technique (Applying backward, upward, Rightward and posterior pressure on the larynx), gum elastic bougie, video laryngoscopy and 2 patients required Fibreoptic bronchoscope. No patient had any desaturation or other airway related complications in the study.

HMDR and Pre E/E-VC both ratios can be used to predict difficult airway, but Pre E/E-VC has more sensitivity than HMDR (92% VS 72%).

LIMITATIONS OF THE STUDY: This study was single centred study with limited study group inter observer variation and Ethnicity may effect the results.

❖ Summary

Majority of the patients were lying in the age group of 41 – 50 years.

- More numbers of males present in the study compared to females.
- Majority of the patients were from grade 1 of CL grading, followed by grade 2, grade 3 and Grade 4.
- 17.8% of the patients were with difficult laryngoscopy and 82.2% of the patients were with easy laryngoscopy
- Mean age, weight and height distribution between easy and difficult laryngoscopy were statistically not significant.
- Mean ratio of HMDN and HMDE was also statistically highly significant(P-value<0.01), with cut off value of 1.14
- Mean ration of preE and E-VC was also statistically highly significant (P-value<0.001), with cut off value of 1.90
- The cut-off value of HMDR to predict a difficult airway was 1.14, with a sensitivity of 70% and a specificity of 85% (P-value <0.001).
- The cut-off value of Pre E/E-VC to predict a difficult airway was 1.90, with a sensitivity of 92% and a specificity of 85% (P-value <0.001).

❖ Conclusion

From above observation and results we conclude that, ultrasound measurement of Pre E/E- VC has high predictability with cutoff value >1.90 for predicting difficult laryngoscopy. US measurement of the HMDR is a potential predictor of difficult laryngoscopy. A value <1.14 is sensitive indicator in predicting a difficult laryngoscopy.

Thus Ultrasound should be incorporated in routine preanesthetic checkup for prediction of difficult airway. PreE/E-VC and HMDR serve as good predictors of difficult airway.

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ANNEXURE – 1

ETHICAL CLEARENCE CERTIFICATE

Azadi Ka Amrit Mahotsav

BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956
Accredited with 'A' Grade by NAAC (Cycle-2)
The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 779/2022-23 30/8/2022

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Friday, 26th August, 2022 at 3.30 p.m. in the Department of Pharmacology** scrutinizes the Synopsis of Post Graduate Student of BLDE (DU)'s Shri B.M.Patil Medical College Hospital & Research Centre from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "Evaluation of efficacy of ultrasonographic airway parameters for predicting difficult airway in patients undergoing elective surgery under general anaesthesia - A Prospective observational study".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: Dr.Dhupati Sethu Siva Kiran

NAME OF THE GUIDE: Dr.Nirmaladevi Kagalkar, Associate Professor, **Dept. of Anaesthesiology**

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA

Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA

MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
BLDE (DU): Phone: +918352-262770, Fax: +918352-263303, Website: www.bldedu.ac.in, E-mail:office@bldedu.ac.in
College: Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

ANNEXURE – II

SAMPLE INFORMED CONSENT FORM

B.L.D.E(DEEMED TO BE UNIVERSITY) SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA – 586103, KARNATAKA

TITLE OF THE PROJECT: "EVALUATION OF EFFICACY OF ULTRASONOGRAPHIC AIRWAY PARAMETERS FOR PREDICTING DIFFICULT AIRWAY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA"

PRINCIPAL INVESTIGATOR: Dr. DHUPATI SETHU SIVA KIRAN

DEPARTMENT OF ANAESTHESIOLOGY,

BLDE'S (DEEMED TO BE UNIVERSITY),

SHRI.B.M. PATIL MEDICAL COLLEGE
HOSPITAL RESEARCH CENTRE,

VIJAYAPURA–586103.

PG GUIDE: DR. NIRMALA DEVI KAGALKAR,

ASSOCIATE PROFESSOR,

DEPARTMENT OF ANAESTHESIOLOGY,

BLDE (DEEMED TO BE UNIVERSITY),

SHRI B.M. PATIL MEDICAL COLLEG

HOSPITAL RESEARCH CENTRE,

VIJAYAPURA -586103.

PURPOSE OF RESEARCH:

I have been informed that this study is: "EVALUATION OF EFFICACY OF ULTRASONOGRAPHIC AIRWAY PARAMETERS FOR PREDICTING DIFFICULT AIRWAY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA"

I have been explained about the reason for conducting this study and selecting me/my ward as a subject for this study. I have also been given a free choice for either being included or not in the study.

PROCEDURE:

I understand that I will be doing "EVALUATION OF EFFICACY OF ULTRASONOGRAPHIC AIRWAY PARAMETERS FOR PREDICTING DIFFICULT AIRWAY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA"

RISKS AND DISCOMFORTS:

I understand that I/my ward may experience hypotension while doing the procedure, and I understand that necessary measures will be taken to reduce these complications as and when they arise.

BENEFITS:

I understand that I/my wards participation in this study will help in finding out "EVALUATION OF EFFICACY OF ULTRASONOGRAPHIC AIRWAY PARAMETERS FOR PREDICTING DIFFICULT AIRWAY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA"

CONFIDENTIALITY:

I understand that medical information produced by this study will become a part of this Hospital records and will be subjected to the confidentiality and privacy regulation of this hospital. Information of a sensitive, personal nature will not be a part of the medical records but will be stored in the investigator's research file and identified only by a code number. The code key connecting name to numbers will be kept in a separate secure location. If the data are used for publication in the medical literature or for teaching purpose, no names will be used and other identifiers such as photographs and audio or 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 this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr. Dhupati sethu siva kiran 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 to 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 that Dr. Dhupati sethu siva kiran will terminate my participation in this study at any time after he has explained the reasons 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 event of injury to me/my ward, resulting directly to my participation in this study, if such injury were 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 any of my legal right.

I have explained

to____, the purpose of this research, the procedures required and the possible risks and benefits, to the best of my ability in patient's own language.

Date: Dr. NIRMALA DEVI KAGALKAR (Guide)

Time : Dr. DHUPATI SETHU SIVA KIRAN

(investigator)

STUDY SUBJECT CONSENT STATEMENT

I confirm that Dr. DHUPATI SETHU SIVA KIRAN 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

"Evaluation of efficacy of ultrasonographic airway parameters for predicting difficult airway in patients undergoing elective surgery under general anesthesia - A prospective observational study"

PATIENT DETAILS: DATE: -

I. Name: Age/ Sex: Ip.No:

II.

1. Type of the surgery:
2. Indication:

III. Significant History:

IV. General Physical Examination:

Pallor: Icterus:
Cyanosis: Clubbing:
Teeth: Dentures:

V. Vital Parameters

Pulse: Blood Pressure:

Respiratory Rate: Temperature:

VI. Systemic Examination

1. CVS:
2. RS:
3. CNS:
4. Per Abdomen:

VII. Airway Assessment:

Mallampati Grade:

Mouth opening:

Cervical spine:

Neck Movement:

VIII. ASA Grade

IX. Preoperative assessment:

A) Ultra sound Measurements

1) Hyomental distance in neutral position (HMDN) (cm)
2) Hyomental distance extension position (HMDE) (cm)
3) Pre epiglottic space (mm) (pre-E)
4) Epiglottis to mid-point of vocal cord (mm) (E-VC)

B) Ratios

a) Pre-E/E-midpoint VC
b) HMDR

X. Intra operative assessment of airway.

A) Cormack - Lehane's grading of laryngoscopic view during intubation.

B) Easy intubation- Cormack and Lehane grade I or II.

C) Difficult intubation-

a) View on laryngoscopy was Cormack and Lehane grade III or IV

b) Three attempts at tracheal intubation.

c) Duration longer than 10 minutes.

d) Failure to intubate or if special manoeuvres were required to facilitate intubation.

DEMOGRAPHIC AND CINICAL PARAMETERS

Name	Age	Height (in cm)	Weight (in kg)	BMI(kg/m^2)

ULTRA SONOGRAPHY PARAMETERS

Name	HMD in neutral position	HMD in extended positions	Pre E	E-VC	HMDR	Pre E/E-mVC

: BIO-DATA OF THE GUIDE

GUIDE NAME	:	DR. K. NIRMALA DEVI
DATE OF BIRTH	:	24/04/1976
EDUCATION	:	MBBS 2000, KURNOOL MEDICAL COLLEGE, KURNOOL ANDHRA PRADESH MD ANAESTHESIOLOGY 2005, KURNOOLMEDICAL COLLEGE KURNOOL, ANDHRA PRADESH.
KMC REG.NO	:	KMC-ANP20010000321KTK
DESIGNATION	:	ASSOCIATE PROFESSOR DEPARTMENT OF ANAESTHESIOLOGY
TEACHING	:	UG AND PG TEACHING EXPERIENCE 14 YEARS
ADDRESS	:	ASSOCIATE PROFESSOR DEPARTMENT OF ANAESTHESIOLOGY B.L.D.E (Deemed to be university) SHRI B.M PATIL MEDICAL COLLEGE ANDRESEARCH INSTITUTE VIJAYAPUR 586103
MOBILE NO	:	8217618954
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INVESTIGATOR

NAME : DR. DHUPTI SETHU SIVA KIRAN

QUALIFICATION : M.B.B.S., (MARCH 2020) SRI DEVERAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

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MOBILE NO 9448221235

EMAIL : sethusivakirandhupati@gmail.com

MASTER CHART

NAME	IP NUMBER	AGE	SEX	HEIGHT	WEIGHT	BMI	PROCEDURE	ASA	MALLAMPATI GRADE	CORMAC AND LEHANE GRADING	HMDN	HMDE	HMDR	Pre E	E-VC	Pre E/E-VC	EASY INTUBATION	DIFFICULT INTUBATION
Malkanna	419676	33	1	160	65	24.977	SEPTOPLASTY	1	II	III	4.3	5.34	1.24	1.84	1.24	1.48		Y
Saheb Gowda	81145	52	1	162	59	25.3906	MRM	1	I	IV	4.12	5.18	1.26	2.12	1.02	2.08		Y
prema rachappa	384439	50	2	161	68	20.7031	LAP CHOLECYSTECTOMY	2	III	III	4.44	5.4	1.22	2.34	1.64	1.43		Y
Bharathi Nagur	403652	33	2	158	51	20.1733	LAP CHOLECYSTECTOMY	2	III	III	4.4	5.4	1.23	2.7	1.68	1.61		Y
Leela yadave	399420	41	2	155	67	27.993	ORIF WITH TENS NAILING	1	II	II	4.2	5.2	1.24	2.24	1.88	1.19	Y	
Nithobha malasidda	397560	34	1	158	59	21.0938	HEMITHYROIDECTOMY	1	II	I	4.4	5.8	1.32	2.06	1.68	1.23	Y	
Supriya Kambal	395383	48	2	156	51	20.0288	LAP APPENDICECTOMY	1	II	II	4.24	5.44	1.28	2.24	1.84	1.22	Y	
Anita shantu	390637	54	2	162	70	20.9566	LAP CHOLECYSTECTOMY	2	II	II	3.8	4.94	1.30	2.24	1.34	1.67	Y	
Jayant walikar	403624	38	1	156	69	21.0962	Tonsillectomy	2	II	I	4.2	5.24	1.25	2.4	2.05	1.17	Y	
Narasappa	404189	48	1	158	56	28.3531	LAVH	2	II	I	4.38	5.66	1.29	2.22	1.24	1.79	Y	
Hanamantappa	353044	34	1	160	61	27.5312	Hemiarthroplasty	2	II	III	4.5	5.8	1.29	2.44	1.46	1.67		Y
sudeep Pawar	393124	47	1	163	68	25.7813	CRIF with PFN	2	III	IV	4.4	5.34	1.21	2.5	1.18	2.12		Y
Shabrine	389772	56	2	156	69	25.5937	external fix of femur fracture	1	III	III	4.6	5.86	1.27	2.3	1.22	1.89		Y
Sushitra	389768	58	2	159	52	28.3531	laminectomy and discectomy	I	I	II	4.2	5.28	1.26	2.3	1.36	1.69	Y	
Lalita	387282	48	2	156	65	20.5688	right PCNL	2	I	II	4.6	5.64	1.23	2.22	1.46	1.52	Y	
Shruthi	361495	45	2	159	60	26.7094	PCNL	1	IV	IV	4.8	5.2	1.08	2.6	1.2	2.17		Y
Channapa	546024	55	1	158	56	23.4221	Left PCNL	2	III	II	4.04	4.96	1.23	2.38	1.42	1.68	Y	
shantaya Math	387011	36	1	158	67	26.7759	wound over nose suturing	1	II	III	4	4.66	1.17	2.24	1.2	1.87		Y
Chandrakanth	379188	31	1	159	64	22.9421	subtotal thyroidectomy	1	II	III	3.84	4.4	1.15	2.24	1.16	1.93		Y
Manjula.B	365900	56	1	157	69	24.974	left hemithyroidectomy	1	III	I	4.2	5.48	1.30	2.35	1.48	1.59	Y	
Sourabh	365875	49	1	157	65	27.993	subtotal thyroidectomy	2	II	II	3.8	4.86	1.28	2.16	1.08	2.00	Y	
Yamanavva	373778	34	2	156	53	26.3702	Left fibroadenoma excision	1	I	II	3.8	4.8	1.26	2.44	1.26	1.94	Y	
Vijaylakshmi	409426	44	2	163	63	23.3355	right pyeloplasty	2	I	I	3.9	5.28	1.35	2.2	1.12	1.96	Y	
Savitri	72679	53	2	163	61	22.6563	Left PCNL	2	I	I	4.4	5.52	1.25	2.44	1.56	1.56	Y	
Soumya	73874	32	2	159	65	22.9591	Left PCNL	2	II	II	3.8	4.84	1.27	2.36	1.44	1.64	Y	
Umesh Katti	371604	46	1	161	51	20.3244	urethroplasty	1	II	II	4	4.98	1.25	2.02	1.14	1.77	Y	
Rukmabai	266678	39	2	161	66	19.6752	Left PCNL	1	II	II	4.36	5.66	1.30	1.82	2.05	0.89	Y	
Parashuram	371601	36	1	157	54	25.462	right PCNL	1	II	II	3.78	4.88	1.29	1.63	2	0.82	Y	

Harish	371597	41	1	160	57	21.9076	Right PCNL	1	II	I	4.5	5.8	1.29	1.24	0.7	1.77	Y	
Lokesh	371596	52	1	164	56	25.8065	D11 D12 laminectomy	2	III	III	3.68	4.22	1.15	2.04	1.04	1.96		Y
Suresh	367021	50	1	157	60	20.8209	Left PCNL	1	I	II	4.4	5.6	1.27	2.11	2	1.06	Y	
Jagadish Goud	368337	34	1	161	54	27.2392	Trans hiatal oesophagectomy	2	III	IV	4	4.4	1.10	1.98	0.98	2.02		Y
Ningamma	101656	59	2	160	68	23.0518	Right PCNL	2	II	II	4.46	5.64	1.26	2.26	2.15	1.05	Y	
Bhagyashree	36198	34	2	163	51	26.5625	Left PCNL	1	I	I	4.28	5.08	**1.19**	2.5	2.19	1.14	Y	
Gajanna	368381	53	1	159	57	19.1953	LAP APPENDICECTOMY	1	I	II	3.6	4.08	***1.13***	2.25	2	1.13	Y	
Mehaboob sab	106904	51	1	159	61	22.5466	LAP CHOLECYSTECTOMY	1	I	I	3.7	4.34	***1.17***	2.05	1.5	1.37	Y	
Ratnamma	31458	43	2	165	65	24.1288	LAP CHOLECYSTECTOMY	2	I	I	3.95	4.48	***1.13***	2.08	1.88	1.11	Y	
Jabeen	19027	56	1	164	65	27.5873	LIVER ABSCESS LAPROTOMY	1	II	II	4	4.42	**1.11**	2.04	1.77	1.15	Y	
Chinnama	58594	36	2	159	54	24.1672	Left fibroadenoma excision	1	I	I	4.25	5.36	1.26	2.5	2.2	1.14	Y	
H.M.Hadgalli	49973	44	1	165	68	21.3599	LAP CHOLECYSTECTOMY	2	II	II	4.1	5.2	1.27	1.15	0.85	1.35	Y	
Ahmed mehaboob sa	73574	53	2	158	56	24.977	WHIPPLES PROCEDURE	2	II	I	4.8	6.25	1.30	2.4	2.05	1.17	Y	
Mahesh	72671	38	1	162	64	22.4323	LAPROTOMY	2	II	I	4.9	6.08	1.24	1.18	0.95	1.24	Y	
Hemalatha	58585	48	2	163	53	24.3865	Left PCNL	2	I	II	4.2	5.8	1.38	2.1	2	1.05	Y	
Roopa Chandrappa	65674	45	2	165	54	24.6097	LAP CHOLECYSTECTOMY	1	I	I	3.8	5.22	1.37	1.19	0.65	1.83	Y	
Gangawwa	46806	39	2	159	63	27.2392	LAP APPENDICECTOMY	1	I	I	4.1	5.48	1.34	2	2	1.00	Y	
Bharathi Navi	57408	58	2	158	55	22.5827	MESH HERNIOPLASTY	1	I	II	3.9	5.12	1.31	2	1.5	1.33	Y	
Mallappa	75326	48	1	159	67	23.9361	RIGHT PCNL	1	II	I	4	5.5	1.38	2.1	1.3	1.62	Y	
Renuka	59553	51	2	163	69	26.5021	LAP APPENDICECTOMY	1	I	I	3.5	4.64	1.33	2.05	1.9	1.08	Y	
Pooja	62247	32	2	158	51	25.9701	LAP APPENDICECTOMY	1	I	I	4.2	5.46	1.30	2.02	1.2	1.68	Y	
Mallayya	51494	47	1	158	58	20.4294	LAP CHOLECYSTECTOMY	2	II	I	4.8	6.18	1.29	2.1	1.8	1.17	Y	
Sreedevi	29809	48	2	159	58	20.3244	LAP APPENDICECTOMY	1	I	I	3.8	5.12	1.35	1.86	1.3	1.43	Y	
Lalbasha	368098	57	1	161	51	21.4844	MRM	2	I	I	4.5	6.06	1.35	1.9	1.7	1.12	Y	
Veena Patil	52726	50	2	163	63	22.9421	SQUAMOUS CELL CA EXCISION	2	1	I	4.15	5.18	1.25	1.16	1	1.16	Y	
Adarsh	18843	51	1	157	57	19.6752	EXP LAPROTOMY	2	1	I	3.55	4.8	1.35	1.7	1.4	1.21	Y	
Milind	69000	53	1	155	55	23.1247	EXP LAPROTOMY	2	I	I	3.86	5.22	1.35	1.8	1.6	1.13	Y	
Rachita Toravi	41010	35	2	158	68	22.8928	LAP APPENDICECTOMY	2	I	I	3.7	4.88	1.32	1.5	1.5	1.00	Y	
Kavita Kembogi	41008	45	2	163	70	21.0772	LAP CHOLECYSTECTOMY	1	I	I	3.95	5.18	1.31	1.25	1.5	0.83	Y	
Bhagyashree	36198	51	2	159	67	22.9421	LAP CHOLECYSTECTOMY	1	I	I	4	5.24	1.31	1.9	1.1	1.73	Y	
Mahadevi	18868	48	2	162	61	26.5021	LAP APPENDICECTOMY	1	II	I	4.25	5.84	1.37	1.8	1.7	1.06	Y	
Mangla bai	32219	31	2	158	54	23.2434	MESH HERNIOPLASTY	2	II	I	4.35	5.5	1.26	1.7	1.6	1.06	Y	

Sulochana	149355	56	2	158	63	21.6311	LAP APPENDICECTOMY	1	I	I	4.8	6.25	1.30	2.5	2.2	1.14	Y	
Lakshmi kanth Ganti	231324	51	1	158	51	25.0657	LAP APPENDICECTOMY	2	I	I	4.9	6.04	1.23	2.12	1.34	1.58	Y	
Alexander.B	34895	47	1	164	57	19.5717	LAP APPENDICECTOMY	2	I	I	4.2	5.8	1.38	2.5	2.2	1.14	Y	
Kallappa	37271	40	1	161	66	27.1203	LAP CHOLECYSTECTOMY	2	II	I	3.8	5.24	1.38	1.15	0.85	1.35	Y	
Dilshan Monia	24268	36	2	165	64	24.7676	LAP APPENDICECTOMY	2	I	I	4.24	5.68	1.34	2.4	2.05	1.17	Y	
Lakshmibai	109175	35	2	165	51	28.0404	LAP CHOLECYSTECTOMY	2	I	I	4.04	5.42	1.34	1.18	0.95	1.24	Y	
Vishal	40399	39	1	158	64	20.3125	LAP CHOLECYSTECTOMY	1	I	II	4	5.5	1.38	2.1	2	1.05	Y	
Kasturibai	102088	36	2	165	59	20.4491	RGHT TYMPANOPLASTY	1	II	II	3.82	5	1.31	1.19	0.65	1.83	Y	
Renuka	120358	35	2	155	56	21.6713	ORIF WITH PLATING	1	I	I	4.46	5.64	1.26	2	2	1.00	Y	
Suresh Sharanappa	44603	49	1	157	68	23.3091	Left PCNL	1	III	III	3.86	4.4	1.14	2.22	1.14	1.95		Y
Sarojini	166848	33	2	160	67	23.7118	LAP HERNIOPLASTY	2	I	I	3.88	4.94	1.27	1.45	0.8	1.81	Y	
Savitri	147605	55	2	156	66	20.4491	LAP MESH HERNIOPLASTY	1	I	II	3.92	5.34	1.36	1.55	0.9	1.72	Y	
Madhura	145829	36	2	155	54	23.1473	PITUITARY MACROADENOMA	2	I	I	4.8	6.12	1.28	1.82	2.05	0.89	Y	
Mallama	145830	48	2	158	53	22.4766	CRANIOPLASTY	2	II	II	3.88	5.28	1.36	1.63	2	0.82	Y	
Vijay lakshmi	141142	39	2	157	60	26.3465	HELLERS CARDIOMYOTOMY	2	I	I	4.5	5.48	1.22	1.24	0.8	1.55	Y	
Saraswathi	346176	52	2	164	55	29.1363	CA LIP EXCISION	2	II	II	4.6	5.85	1.27	2.1	1.4	1.50	Y	
Suresh Sivanna	369435	57	1	164	63	23.7332	LAP APPENDICECTOMY	1	I	I	4.4	5.44	1.24	2.05	1.9	1.08	Y	
Prabhu	136649	54	1	164	66	20.4294	LAP CHOLECYSTECTOMY	2	II	II	4.8	6.1	1.27	2.02	1.2	1.68	Y	
Neelavva	408720	42	2	163	68	25.5937	Left PCNL	1	II	I	4.4	5.9	1.34	2.1	1.8	1.17	Y	
Nilabai	24361	51	2	165	68	25.5937	right pyeloplasty	1	II	II	3.8	4.9	1.29	1.15	1.3	0.88	Y	
Bibijan	364362	35	2	160	53	22.4813	LAP CHOLECYSTECTOMY	1	I	I	3.98	5.2	1.31	1.9	1.7	1.12	Y	
Mustak	8427	44	1	163	61	26.2336	NASAL BONE FRACTURE RED	1	I	I	3.78	5.02	1.33	0.6	1	0.60	Y	
Indrabai	363834	44	2	159	51	22.2063	left hemithyroidectomy	2	I	I	4	4.98	1.25	0.7	1.4	0.50	Y	
Rachappa	406871	30	1	158	54	20.4294	MANDIBLE # FIXATION	1	II	II	3.98	5.38	1.35	1.8	1.6	1.13	Y	
Sheela Rajput	370690	34	2	163	63	22.0317	EXP LAPROTOMY	2	I	II	3.94	5.26	1.34	1.5	1.5	1.00	Y	
Gangabai	384426	54	2	160	54	23.7118	HYDATID CYST EXCISION	1	I	I	3.7	5.12	1.38	1.18	0.95	1.24	Y	
yallawwa	381462	57	2	155	61	23.4236	Right PCNL	1	II	I	4.8	6.2	1.29	2.1	2	1.05	Y	
Jyoti Bagalkot	396794	51	2	158	50	25.3902	DIAGNOSTIC LAP	1	I	I	4.02	5.24	1.30	1.19	0.65	1.83	Y	
Shamda sabamna	339775	46	2	157	52	26.6728	RIGHT FTP CRANIOTOMY	2	III	III	4.1	4.64	1.13	2.38	1.24	1.92		Y
Prashanth	400472	36	1	156	67	21.6041	LEUKOPLAKIA MANDIBULECTOM	2	I	II	4	5.12	1.28	1.25	0.85	1.47	Y	
Govinda Hatti	393125	46	1	162	63	23.8281	MRM	2	I	I	4.2	5.35	1.27	1.45	0.8	1.81	Y	
Sivalela	389776	40	2	160	66	24.0055	DACROCYSTORHINOSTOMY	1	II	I	4.4	5.6	1.27	1.55	0.9	1.72	Y	
Rani	381743	58	2	158	67	23.7332	TAH	1	I	II	4.6	5.85	1.27	1.82	2.05	0.89	Y	

Anwitha	381727	51	2	156	57	24.9108	Tonsillectomy	1	I	I	4.4	6.02	1.37	1.63	2	0.82	Y	
Ashwini ashok	381525	52	2	160	63	22.4323	R EAR KELOID EXCISION	1	I	I	4.8	6.5	1.35	1.24	0.9	1.38	Y	
Meenakshi	364157	41	2	157	55	24.6094	LAVH	1	I	I	4.4	5.9	1.34	1.8	1.7	1.06	Y	
Allan	389574	39	1	157	66	22.3133	Left PCNL	1	II	II	3.8	4.9	1.29	1.7	1.6	1.06	Y	
Gous Mohamed	333103	31	1	157	54	26.8386	LAVH	1	II	II	3.8	4.88	1.28	2.5	2.2	1.14	Y	
komali	379312	40	2	155	64	21.9076	LAP CHOLECYSTECTOMY	2	II	II	3.6	4.68	1.30	1.15	2.12	0.54	Y	
Mahantayya	380257	33	1	155	56	25.3155	L MANDIBLE # FIXATION	1	II	II	4	5.2	1.30	2.5	2.2	1.14	Y	
Sandeep Hugar	368380	56	1	164	69	23.3091	LYMPH NODE EXCISION	1	I	II	3.8	4.89	1.29	1.15	0.85	1.35	Y	
Sharanabai	380209	35	2	164	59	25.6544	FESS	1	II	I	3.5	4.64	1.33	2.4	2.05	1.17	Y	
Shilpa	377564	43	2	165	70	19.9481	Tonsillectomy	1	I	I	4.64	5.84	1.26	1.18	0.95	1.24	Y	
Mahalakshmi	367100	46	1	163	60	25.7117	NASAL BONE FRACTURE RED	1	I	I	4.8	5.98	1.25	2.1	2	1.05	Y	
Devendra Gani	368379	47	1	156	61	22.5827	MANDIBLE # FIXATION	2	IV	III	4.44	5.14	1.16	2.22	1.18	1.88		Y
Vijaylakshmi	365912	53	2	155	60	23.7118	SEPTOPLASTY	1	I	I	4.5	5.6	1.24	2	2	1.00	Y	
Lakshmi	70872	54	2	160	58	23.7118	EXP LAPROTOMY	2	II	III	4.58	5.28	1.15	1.88	0.98	1.92		Y
Rukmabai	68045	50	2	157	57	25.711	LAP CHOLECYSTECTOMY	2	I	I	4.2	5.8	1.38	1.15	0.85	1.35	Y	
Shanin Balgar	210777	49	1	159	58	23.1247	LAP CHOLECYSTECTOMY	2	II	II	3.8	5.24	1.38	2.4	2.05	1.17	Y	
Chandranna	370753	41	1	160	70	22.9421	SEPTOPLASTY	1	II	I	4.28	5.6	1.31	1.18	0.95	1.24	Y	
Sushmitha	364475	45	2	163	54	27.3438	ANT CERVICAL DECOMPRESSION	1	I	II	3.9	5.36	1.37	2.1	2	1.05	Y	
Renuka	342651	57	2	156	57	24.3418	COLOSTOMY CLOSURE	2	I	I	4	5.5	1.38	1.19	0.65	1.83	Y	
Kalpana	58801	31	2	162	58	19.9481	ELECTIVE LSCS	2	II	II	3.8	4.8	1.26	2	2	1.00	Y	
Supriya	58781	59	2	165	67	22.1003	THYROGLOSSAL CYST	1	II	I	4	5.2	1.30	2	1.5	1.33	Y	
Ganagabai	38360	49	2	158	68	19.8347	CA RECTUM APR	3	I	I	4.8	6.08	1.27	2.1	1.6	1.31	Y	
Sangamma Mane	57410	51	2	157	61	24.9199	CRANIOTOMY	2	II	IV	4.84	5.2	1.07	2.4	1.06	2.26		Y
Shabana	39696	32	2	157	59	21.9363	FESS SEPTOPLASTY	1	I	II	3.8	4.98	1.31	2.02	1.2	1.68	Y	
Lakmavva	50117	53	2	155	65	23.2335	L TYMPANOMASTOIDECTOMY	1	I	I	4	5.26	1.32	2.1	1.8	1.17	Y	
Savitri	30461	47	2	157	58	27.0552	HYSTEROLAPROSCOPY	1	II	II	4.2	5.35	1.27	1.15	1.3	0.88	Y	
Prashanth	106549	51	1	161	50	23.5304	Left PCNL	1	II	II	4.4	5.6	1.27	1.9	1.7	1.12	Y	
Jakkamma	33711	46	2	163	54	19.2894	LAPROTOMY	2	II	I	4.6	5.85	1.27	1.16	1	1.16	Y	
Pushpa	55639	43	2	157	66	22.9421	HUMERUS # ORIF	1	II	II	4.4	5.4	1.23	1.15	0.75	1.53	Y	
Mahananda	41413	38	2	160	55	26.7759	HUMERUS # ORIF	2	III	II	4.8	5.8	1.21	1.6	1	1.60	Y	
Pooja Heramath	30134	42	2	160	68	19.6752	CRANIOPLASTY	1	II	I	4.4	5.9	1.34	2.05	1.2	1.71	Y	
Ningamma Biradar	46834	47	2	158	69	26.5625	TYMPANOMASTOIDECTOMY	2	I	II	3.8	4.9	1.29	2	1.5	1.33	Y	
Pooja.k	48959	32	2	159	52	23.7118	FESS SEPTOPLASTY	1	I	I	3.8	4.86	1.28	2.01	1.1	1.83	Y	

Jayashri	268043	43	2	160	66	23.634	CA LIP EXCISION	1	II	II	4.2	5.8	1.38	1.8	1.4	1.29	Y	
Dayanada	16965	57	1	159	57	27.5873	LAP CHOLECYSTECTOMY	1	II	I	3.8	5.12	1.35	1.74	1.18	1.47	Y	
Renuka	108034	39	2	157	60	22.5466	right pyeloplasty	1	II	II	4.1	5.6	1.37	1.19	2	0.60	Y	
Mahadevi	135504	43	2	161	52	24.3418	LAP CHOLECYSTECTOMY	2	II	II	3.9	4.94	1.27	1.16	0.7	1.66	Y	
Chidanand navi	146435	48	1	157	54	21.2306	NASAL BONE FRACTURE RED	2	II	I	4	5.5	1.38	1.9	1.2	1.58	Y	
Pooja	130378	37	2	157	57	24.3418	RIGHT FTP CRANIOTOMY	2	II	I	4.2	5.4	1.29	2.5	2	1.25	Y	
Shekubai	107590	56	2	159	67	20.4491	EUKOPLAKIA MANDIBULECTOI	2	II	III	4.68	5.46	1.17	2.06	1.06	1.94		Y
Aravind	135377	40	1	159	60	26.5021	DACROCYSTORHINOSTOMY	2	III	IV	4.6	5	1.09	2.16	1.02	2.12		Y
Basanna	405415	46	1	158	55	22.0317	L MANDIBLE # FIXATION	1	III	III	4.8	5.5	1.15	2.13	1.08	1.97		Y
Basavaraj	405460	34	1	164	63	23.4236	LYMPH NODE EXCISION	I	I	II	4.5	5.8	1.29	2.3	2.1	1.10	Y	
Sharanabai	364429	35	2	163	62	23.3355	Tonsillectomy	2	I	II	4.15	5.48	1.32	2.4	2.14	1.12	Y	
Kalyan Kumar	332445	41	1	158	68	27.2392	NASAL BONE FRACTURE RED	1	IV	IV	4.68	5.2	1.11	2.36	1.08	2.19		Y
Babar Abdul Rahe	58479	37	1	163	60	22.5827	MANDIBLE # FIXATION	2	III	II	4.2	5.16	1.23	1.18	1.5	0.79	Y	
Dhanu	64610	56	1	165	53	19.4674	SEPTOPLASTY	1	II	III	4.72	5.42	1.15	2.18	1.12	1.95		Y
Raja	44879	40	1	158	59	23.634	THYROGLOSSAL CYST	1	II	III	4.32	5.02	1.16	2.46	1.24	1.98		Y
Basamma	84945	41	2	160	52	20.3125	L TYMPANOMASTOIDECTOMY	1	III	I	4	5.4	1.35	1.16	1	1.16	Y	
Ganesh	20723	54	1	164	55	20.4491	Left PCNL	2	II	II	4.25	5.24	1.23	1.7	1.4	1.21	Y	
Rajesh	31247	46	1	163	63	23.7118	HUMERUS # ORIF	1	I	II	4.35	5.5	1.26	1.8	1.6	1.13	Y	
Siddamma	146922	60	2	163	70	26.3465	right pyeloplasty	2	I	I	4.8	6.25	1.30	1.5	1.5	1.00	Y	
Samarth	35356	50	1	155	70	29.1363	urethroplasty	2	I	I	4.9	6.4	1.31	1.25	1.5	0.83	Y	
Arun Marate	123106	37	1	158	51	20.4294	Right PCNL	2	II	II	4.2	5.8	1.38	1.94	1.22	1.59	Y	
Sharubai	5627	32	2	163	59	22.2063	Left PCNL	1	II	II	3.8	4.92	1.29	1.8	1.8	1.00	Y	
Roopa	399646	52	2	157	69	27.993	Right PCNL	1	II	II	4.1	5.44	1.33	1.7	1.6	1.06	Y	
Gurunath	394700	34	1	161	56	21.6041	Left PCNL	1	II	II	3.9	4.94	1.27	1.55	0.98	1.58	Y	
Raju Heramath	381745	36	2	164	67	24.9108	LAP APPENDICECTOMY	1	II	I	4	5.5	1.38	1.82	2.05	0.89	Y	
Meenakshi	379306	55	1	159	58	22.9421	LIVER ABSCESS LAPROTOMY	2	III	III	4.48	5.18	1.16	2.18	1.18	1.85		Y
Santosh	377359	55	1	163	53	19.9481	LAP CHOLECYSTECTOMY	1	I	II	4	5.48	1.37	1.24	0.96	1.29	Y	
Veena	377562	39	2	163	63	23.7118	LAPROTOMY	2	III	IV	5.2	5.7	1.10	2.18	1.02	2.14		Y
Rudramma	365671	41	2	162	59	22.4813	Left PCNL	2	II	II	3.6	4.42	1.23	2.25	2	1.13	Y	
Kasturi	65825	47	2	155	62	25.8065	LAP CHOLECYSTECTOMY	1	I	I	4.5	6.02	1.34	2.05	1.5	1.37	Y	
Gourabai	99301	31	2	164	62	23.0518	LAP APPENDICECTOMY	1	I	II	4.6	5.85	1.27	1.15	2.2	0.52	Y	
Vinayak	15633	35	1	157	68	27.5873	LAP APPENDICECTOMY	1	I	I	4.4	5.68	1.29	1.15	2.12	0.54	Y	
Pralhad Kulkarni	76541	43	1	164	59	21.9363	LAP CHOLECYSTECTOMY	2	I	I	4.8	5.94	1.24	2.5	2.2	1.14	Y	
Shruthi	43364	39	2	159	58	22.9421	LAP CHOLECYSTECTOMY	1	II	II	4.4	5.9	1.34	1.15	0.98	1.17	Y	
Basavaraj	24520	41	1	156	66	27.1203	ORIF WITH TENS NAILING	1	I	I	3.8	4.9	1.29	2.4	2.05	1.17	Y	
Husnappa Jakkapp	394547	45	1	162	65	24.7676	LAPROTOMY	2	II	II	3.8	4.96	1.31	1.18	0.95	1.24	Y	
Renuka	10304	57	2	164	57	21.1927	Tonsillectomy	2	II	I	3.86	5.12	1.33	2.1	2	1.05	Y	
Shaheen Shakira H	68141	32	1	164	55	20.4491	CRIF with PFN	2	I	I	4	5.24	1.31	1.19	0.98	1.21	Y	
Roopa	145828	32	2	161	60	23.1473	External fix of femur fracture	1	I	I	3.8	4.88	1.28	2	2	1.00	Y	

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