

**ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH
SCIENCES DEPARTMENT OF ANESTHESIA**



**Magnitude And Predictive Values Of Preoperative Tests For
Difficult Laryngoscopy And Intubation Among Surgical Patients
Who Underwent Elective Surgery Under General Anesthesia In
Tikur Anbessa Specialized Hospital From February1 To March 30,
2016**

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**Thesis Submitted to Department of Anesthesia College of Health Sciences, Addis
Ababa University in partial fulfillment of the requirements for the degree of master
of Anesthesia**

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June, 2016

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Acknowledgment

First of all, I would like to express my appreciation to the department of Anesthesia for its encouragement to conduct this thesis. My deepest gratitude extends to my advisor Mr. WosenyelehAdmasu for his close advice, guidance and constructive comments throughout the conduct of this thesis. Lastly, but not the least I would like to thank my data collectors for their invaluable contribution for the accomplishment of this thesis work.

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Abbreviations and Acronyms

ASA	American Society of Anesthesiologists
AUC	Area under the Curve
DA	Difficult Airway
DAS	Difficult Airway Society
DI	Difficult Intubation
DL	Difficult Laryngoscopy
ETT	Endotracheal Tube
GA	General Anesthesia
IID	Inter Incisor Distance
IIG	Inter Incisor Gap
LEMON	Look externally, Evaluate 3-3-2, Mallampatti class, Obstruction and Neck mobility
MMC	Modified Mallampatti Class
MMT	Modified Mallampatti Test
MOH	Ministry of Health
MP	Mandibular Protrusion
ROC	Receiver Operating Characteristics
SMD	Sternomental Distance
TASH	TikurAnbessa Specialized Hospital
TMD	Thyromental Distance
ULBT	Upper Lip Bite Test

Abstract

Introduction: The significance of difficult or failed tracheal intubation following induction is well-recognized cause of morbidity and mortality in anesthetic practice. Nevertheless, the need to predict potentially difficult tracheal intubation has received a little attention. During routine anesthesia the incidence of difficult tracheal intubation has been estimated at 1.5% - 8% of general anesthetics. Difficulties in intubation have been associated with serious complications, such as brain damage or death, particularly when failed intubation has occurred. Occasionally in a patient with a difficult airway, the anesthetist is faced with the situation where mask ventilation proves difficult or impossible. This is one of the most critical emergencies that may be faced in the practice of anesthesia. If the anesthetist can predict which patients are likely to prove difficult to intubate, he/she may reduce the risks of anesthesia considerably. In Ethiopia there is no data on the magnitude of difficult laryngoscopic tracheal intubation and no standard guideline for preoperative tests. The main concern of this study was to provide information on the magnitude of difficult laryngoscopic intubation and to determine valuable preoperative tests to predict difficult laryngoscopy and intubation in patients with apparently normal airways which can help anesthetists to improve preoperative airway assessment and contribute to decrease anesthesia related morbidity and mortality.

Objective: The main objective of this study was to assess the magnitude and predictive values of preoperative tests for difficult laryngoscopy and intubation, among surgical patients who underwent elective surgery under general anesthesia with endotracheal intubation in Tikur Anbessa Hospital from February 1- March 30, 2016.

Study design: A facility based cross sectional study design was used.

Result: In this study, we found the magnitude of difficult laryngoscopy and intubation as 13.6% and 5% respectively. 33.3% of Patients with difficult laryngoscopy were found to be difficult for intubation. Mallampatti test, interincisor distance and thyromental distance were identified to be good preoperative tests to predict difficult laryngoscopic intubation when used in combination.

Recommendation: We recommend anesthesia professionals to use combination of MMC/TMD/IID for their routine preoperative airway assessment.

1. Introduction

1.1. Background information

The term 'airway' in its day-to-day usage refers to the upper airway which may be defined as the extrapulmonary air passage, consisting of the nasal and oral cavities, pharynx, larynx, trachea and large bronchi. 'Difficult airway' is one in which there is a problem in establishing or maintaining gas exchange via a mask, an artificial airway or both. Recognizing the potential for a difficult airway (DA) in a designated 'Difficult airway clinics' allows time for optimal preparation, proper selection of equipment and technique and participation of personnel experienced in difficult airway management (1, 2). For securing the airway, tracheal intubation using direct laryngoscopy remains the method of choice in most cases. However, difficult laryngoscopic tracheal intubation occurs in 1.5% - 8% of general anesthetics (3). Difficulty in airway management is a major cause of morbidity and mortality in anesthetic practice (4).

Difficult laryngoscopy (poor glottis visualization) is considered as a surrogate indicator of difficult intubation (2). The ability to identify patients at risk of difficult tracheal intubation is important especially in patients with apparently normal airways. The diagnostic accuracy of the screening tests varies between different studies. This is attributed to the difference in the incidence of difficult laryngoscopy and intubation, inadequate statistical power, different test thresholds and differences in patient characteristics. Differences in patient characteristics may also influence the incidence of difficult laryngoscopy and difficult intubation (4).

The anesthesia preoperative evaluation is the clinical foundation and framework of perioperative patient management and can potentially reduce operative morbidity and enhance patient outcomes (5). Parameters, such as interincisor distance (IID), mandibular protrusion (MP), thyromental distance (TMD), sternomental distance (SMD), oropharyngeal space (modified mallampatti class) and grade of laryngoscopic view are the most commonly used preoperative tests, that can assist to predict difficult intubation. For each of these parameters, there are several airway measures available, and their reliability and predictive ability varies widely. This study will assess the magnitude and validity of airway parameters in predicting difficult laryngoscopic intubation for general anesthesia (GA) in adults and effect of combining the parameters on the validity.

1.2. Statement of the Problem

Black lion hospital (TikurAmbessa in Amharic), located in the nation's capital Addis Ababa, is Ethiopia's largest public hospital. In 1998 TASH which is also the largest referral hospital in the country was given to Addis Ababa University by the Ministry of Health (MOH) for the health faculty as a main teaching hospital. The faculty is the oldest and the largest among the health training institutions in the country, staffed with the most senior specialists. The hospital provides tertiary level referral treatment. It offers diagnosis and treatment for approximately 370,000-400,000 patients a year. The hospital has 800 beds and 17 operation rooms. But due to reformation, currently only 8 operation rooms are functional and approximately 7000-9000 patients undergo surgery in a year including cesarean section and emergency surgery.

Expertise in airway management is essential in every medical specialty. Maintaining a patent airway is essential for adequate oxygenation and ventilation and failure to do so, even for a brief period of time, can be life threatening. Respiratory events are the most common anesthetic related injuries. The three main causes of respiratory related injuries are inadequate ventilation, esophageal intubation and difficult tracheal intubation. Difficult tracheal intubation accounts for 17% of the respiratory related injuries and results in significant morbidity and mortality. In fact up to 28% of all anesthetic related deaths are secondary to the inability to mask ventilate or intubate (2). The incidence of difficult laryngoscopy and intubation in Indian patients was 9.7% and 4.5%, respectively (4).

Unanticipated difficult laryngoscopic intubation places patients at increased risk of complications ranging from sore throat to serious airway trauma, brain damage even death. These complications are probably the result of a lack of accurate predictive tests for difficult intubation and inadequate preoperative examinations of the airway (4).

Because difficult or failed endotracheal intubations are one of the leading cause of anesthesia related morbidity and mortality in anesthetized patients there is a need for accurate tests to predict difficult intubation (6, 7). The ability to identify patients at risk of difficult tracheal intubation is important especially in patients with apparently normal airways. There is no standard guideline for preoperative tests in most of Ethiopian hospitals.

Preoperative assessment of various anatomic and clinical features helps in identifying potentially difficult laryngoscopy (4). However, the diagnostic accuracy of screening parameters varies between different studies because of patients' ethnic group, sex, physical and medical characteristics. For example, in Asian patients it may be more difficult to intubate the trachea than in Caucasians (3, 4). Moreover, most studies do not provide a 'measure' of difficult intubation in patients with difficult laryngoscopy. This is attributed to difference in incidence of difficult laryngoscopy and intubation, and inadequate statistical power of different tests. In addition to this, none of the studies of difficult laryngoscopy and intubation have been performed in Ethiopia.

This study can provide information on the magnitude of difficult laryngoscopy and intubation; and predictive value of common preoperative tests which will contribute in the improvement of preoperative airway assessment to decrease anesthesia related morbidity and mortality.

1.3. Literature Review

Difficult laryngoscopy is inability to view the glottis opening using a conventional curve blade laryngoscope, corresponding to a Cormack and Lehane III or IV grade view, in which only epiglottis and only pharynx and tongue, respectively, may be visualized; whereas difficult intubation is defined as a trained Anesthetist using direct laryngoscopy take's more than 3 attempts or more than 10 minutes to complete tracheal intubation (1, 2, 6). Difficult or failed endotracheal intubation is one of the leading causes of anesthesia-related morbidity and mortality (1, 2, 4, 6).

The unanticipated difficult airway occurs with a low but consistent incidence in anesthesia practice. Literature review from 1990 to 1996 reported as difficult direct laryngoscopy occurs in 1.5-8.5% of general anesthetics and difficult intubation occurs with a similar incidence (3, 8).

Keyvan K. et al (2000) were conducted observational study at tertiary-care level hospital to predict difficult intubation. Of the 461 patients included in this analysis, 38/461 (8.24%) were classified as difficult to intubate (6). Another recent prospective study conducted by Smita P. et al (2013) in India on 330 adult patients to assess the incidence of difficult laryngoscopy and intubation in the Indian population reported the incidence of difficult laryngoscopy and intubation as 9.7% and 4.5%, respectively (4). A more recent study by Bhavdip Patel and his coworkers (2014) showed the incidence of difficult endotracheal intubation as 8.1% (7).

Because of failed endotracheal intubation is a principal cause of morbidity and mortality in anesthetized patients, there is a need for accurate tests to predict difficult intubation (9). This risk can be reduced if patient's airway is evaluated preoperatively (7).

Mostly cited preoperative tests to predict the absence or presence difficult laryngoscopy and intubation are: Modified Mallampatti class (MMC), interincisor distance (IID), thyromental distance (TMD), sternomental distance (SMD), mandibular protrusion and Cormack and Lehane laryngoscopic grade (4, 5, 7, 8, 9). These tests are very cheap, simple and easily applicable in clinical practice by any level of anesthesia professionals.

Assessment techniques which utilize multiple characteristics to derive a risk factor tend to be more accurate predictors. Literatures have recommended that the use of combined preoperative measurement parameters in predicting difficult intubation. However, limited information is available on effect of combining these parameters in enhancing the validity of parameters.

Savva D. (1994) conducted a prospective study to predict difficult tracheal intubation on 350 patients and he found difficult tracheal intubation in 17/350(4.9%) patients, of whom four (1.14%) had a grade III or IV view on laryngoscopy. A sternomental distance of 12.5 cm or less with the head fully extended on the neck and the mouth closed predicted 14 of the 17 patients in whom tracheal intubation was difficult. As a screening test, sternomental distance appeared to be more sensitive (82.4%) and more specific (88.6%) than thyromental distance (64.7% and 81.4%, respectively), the modified Mallampatti test (64.7% and 66.1%, respectively) and forward protrusion of the mandible (29.4% and 85.0%, respectively)(10).

Tse,Hussain, Jimson C. et al (1995), were conducted a prospective blind study to determine whether a difficult endotracheal intubation could be predicted preoperatively by evaluation of one or more anatomic features of the head in St. Elizabeth's Medical Center of Boston. A total of 471 patients (220 men and 251 women aged 18-89 year) were enrolled in the study. Sixty-two of them were found at laryngoscopy to have airways that were difficult to intubate (laryngoscopy Grade III or IV). There were no failed intubations. Assignment to oropharyngeal Class 3, a thyromental distance ≤ 7 cm, and a head extension ≤ 80 degrees were selected as indicators of difficult intubation (9).Keyvan K. et al (2000) were conducted observational study at tertiary-care level hospital to predict difficult intubation. Of the 461 patients included in this analysis, 38 were classified as difficult to intubate. Multivariable analysis identified three airway tests that were highly significant for predicting difficult tracheal intubation. These were: 1) "mouth opening", 2) "chin protrusion", and 3) "atlanto-occipital extension". Using these tests, a validated, highly reliable and predictive model is produced to determine the probability of difficult intubation for patients.

Patients requiring endotracheal intubation in the resuscitation room of a UK teaching hospital between June 2002 and September 2003 were assessed on criteria based on the LEMON method. At laryngoscopy, the Cormack and Lehane grade was recorded. An airway assessment score was

devised and assessed. 156 patients were intubated during the study period. There were 114 Cormack and Lehane grade 1 intubations, 29 grade 2 intubations, 11 grade 3 intubations, and 2 grade 4 intubations. Patients with large incisors ($p, 0.001$), a reduced inter-incisor distance ($p, 0.05$), or a reduced thyroid to floor of mouth distance ($p, 0.05$) were all more likely to have a poor laryngoscopic view (grade 2, 3, or 4). Patients with a high airway assessment score were more likely to have a poor laryngoscopic view compared with those patients with a low airway assessment score ($p, 0.05$). An airway assessment score based on criteria of the LEMON method is able to successfully stratify the risk of intubation difficulty in the emergency department. Patients with a poor laryngoscopic view (grades 2, 3, or 4) were more likely to have large incisors, a reduced inter-incisor distance, and a reduced thyroid to floor of mouth distance (11).

Iohom G, Ronayne M & Cunningham AJ. (2003) conducted a study on a total of 212 (109 male, 103 female) non-obstetric surgical patients, aged >18 yr, undergoing elective surgical procedures requiring tracheal intubation by assessing preoperatively with respect to the oropharyngeal (modified Mallampati) classification, thyromental and sternomental distances. An experienced anesthetist, blinded to the preoperative airway assessment, performed laryngoscopy and graded the view according to Cormack and Lehane's classification. Twenty tracheal intubations (9%) were difficult as defined by a Cormack and Lehane Grade 3 or 4, or the requirement for a bougie in patients with Cormack and Lehane Grade 2. Used alone, the Mallampati oropharyngeal view, and thyromental and sternomental distances were associated with poor sensitivity, specificity and positive predictive values. Combining the Mallampati Class III or IV with either a thyromental distance <6.5 cm or a sternomental distance <12.5 cm decreased the sensitivity (from 40 to 25 and 20%, respectively), but maintained a negative predictive value of 93%. The specificity and positive predictive values increased from 89 and 27% respectively for Mallampati alone to 100%. The findings suggest that the Mallampati classification, in conjunction with measurement of the thyromental and sternomental distances, may be a useful routine screening test for preoperative prediction of difficult tracheal intubation (12).

Merah NA. et al (2005) found difficulty to visualize the larynx in 13/380 (3.4%) patients. The sensitivity, specificity and the positive predictive value for the five airway predictors were: MMT (61.5%; 98.4%; 57.1%), TMD (15.4%; 98.1%; 22.2%), SMD (0%; 100%; 0%), HLM (30.8%, 76.0%; 4.3%) and IIG (30.8%; 97.3%; 28.6%). The best combination of predictors was MMT/TMD/IIG with a sensitivity, specificity and positive predictive value of 84.6%; 94.6%; 35.5% respectively. Logistic regression analysis showed that weight, MMT, IIG and TMD were independent predictors of DVL. They concluded that MMT, TMD and IIG appear to provide the optimal combination in prediction of DVL in a West African population (13).

On the other hand Khan ZH. et al (2009) conducted a prospective study and showed the prevalence of difficult intubation as 5% (n = 19). Class III ULBT, IID <4.5 cm, TMD <6.5 cm, and SMD <13 cm were defined as predictors of difficult intubation. The Specificity and accuracy of the ULBT were significantly higher than TMD, SMD, and IID individually (specificity was 91.69%, 82.27%, 70.64%, and 82.27%, respectively, and accuracy was 91.05%, 71.32%, 81.84%, and 76.58%, respectively). The combination of the ULBT with SMD provided the highest sensitivity. They concluded that the specificity and accuracy of the ULBT is significantly higher than the other tests and is more accurate in airway assessment. However, the ULBT in conjunction with the other tests could more reliably predict easy laryngoscopy or intubation (14).

Another prospective study conducted by Smita P. et al (2013) in India on 330 adult patients to assess the incidence of difficult laryngoscopy and intubation in the Indian population showed the incidence of difficult laryngoscopy and intubation as 9.7% and 4.5%, respectively. Univariate analysis showed that increasing age and weight, male gender, modified Mallampatti class (MMC) 3 and 4 in sitting and supine positions, inter-incisor distance (IID) \leq 3.5 cm, thyromental (TMD) and sternomental distance, ratio of height and TMD, short neck, limited mandibular protrusion, decreased range of neck movement, history of snoring, receding mandible and cervical spondylosis were associated with difficult laryngoscopy. Multivariate analysis identified four variables that were independently associated with difficult laryngoscopy: MMC class 3 and 4, range of neck movement $<80^\circ$, IID \leq 3.5 cm and snoring(4).

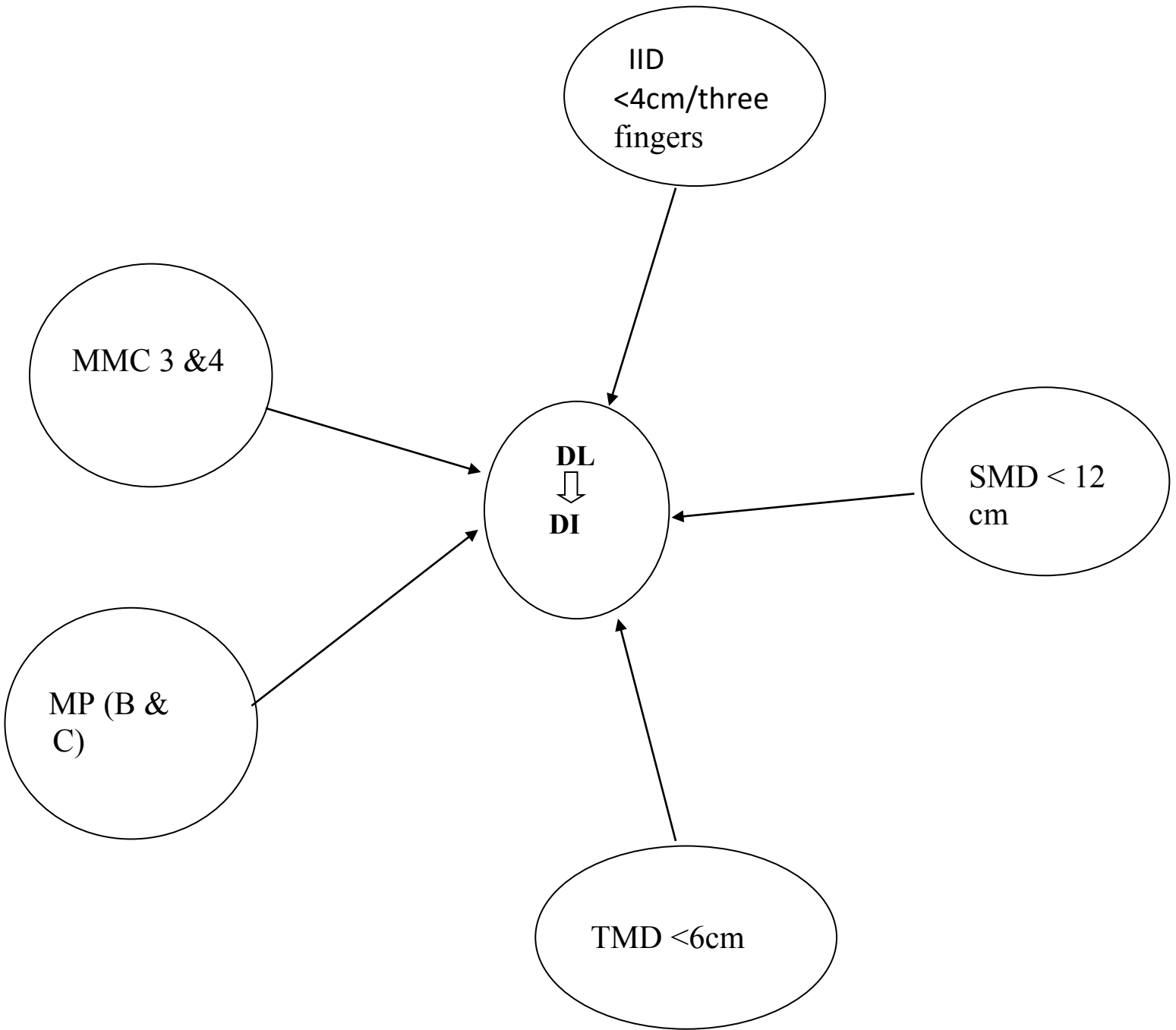
A more recent prospective study by Bhavdip P. et al (2014) conducted to assess the validity of different parameters in predicting difficult intubation for general anaesthesia (GA) in adults and effect of combining the parameters on the validity on 135 patients showed that the sensitivity and specificity of MMT as 28.6% and 93%, respectively. The TMD (<6.5 CM) had sensitivity and specificity of 100% and 75.8%, respectively. The SMD (<12.5 CM) had sensitivity and specificity of 91% and 92.7%, respectively. Combination of MMT grading and TMD and SMD measurements increased the validity (sensitivity of 100% and specificity of 92.7%). They found high specificity in MMT, but suggested that the validity of using combination of MMT, SMD and TMD as compared to MMT alone is very high in predicting difficult intubation in adult patients (7).

As we can see from the above literatures, the diagnostic accuracy of screening tests varies between different studies and most of the researchers recommended the combination of different preoperative tests to increase the validity of parameters in predicting difficult laryngoscopy and intubation. However, in TikurAnbessa specialized Hospital there are no guidelines for preoperative airway assessment and no study is conducted to assess the magnitude and predictive value of preoperative tests even at a national level. There is also limited data on the predictive value of difficult laryngoscopy for difficult intubation.

The incidence of difficult laryngoscopy and intubation is not the same in different studies; this can be due to patients' ethnic group, physical and medical characteristics, skill of the anesthetists and the diagnostic tests used. For example, in Asian patients it may be more difficult to intubate the trachea than in Caucasians (9, 15).

This prospective observational study will assess the magnitude of difficult laryngoscopy and intubation; and predictive value of preoperative tests in estimating difficult laryngoscopic intubation among elective surgical patients in TikurAnbessa Specialized Hospital from Feb. 1 to March 30, 2016. The study also tested the effect of combining different parameters on their validity in predicting difficult intubation. This study is expected to provide information that can help to develop guidelines for preoperative evaluation of patients and can contribute for the improvement of quality of anesthesia care. This study can also be used as a base line data for researchers to carry out a multicenter study at a national level.

1.4. Conceptual Frame work



2. Significance of the Study

Even though difficulty in airway management is a major cause of morbidity and mortality in anesthetic practice, attention is not given for prevalence of this problem and improvement of preoperative Airway assessment. The diagnostic accuracy of preoperative tests varies between different studies. This is attributed to difference in the incidence of difficult laryngoscopy and intubation among different population. Differences in the patient characteristics, clinical setup and skill of the anesthetists can also influence the magnitude of difficult laryngoscopy and intubation. In addition to this, there is no published data on the magnitude or prevalence and predictive values of preoperative tests in our country, even at a national level. Moreover, most studies do not provide a 'measure' of difficult intubation in patients with difficult laryngoscopy.

Evidence based local or national data on the magnitude of the problem and normal values of preoperative tests will help anesthetists to improve quality of anesthesia care. The purpose of this study is therefore, to provide evidence based information to the anesthetists and other concerned professionals on the magnitude of difficult laryngoscopy and intubation as well as to describe the validity of clinically useful preoperative tests for predicting difficult laryngoscopy and difficult intubation in patients with seemingly normal airway in TikurAnbessa Specialized Hospital from Feb.1- March 30, 2016. This study will contribute in the improvement of anesthesia quality care by decreasing morbidity and mortality of patients associated with endotracheal intubation. It can also be used as a base line data for further multicenter studies and for the development of guidelines for preoperative airway assessment to predict difficult laryngoscopic tracheal intubation.

3. Objectives

3.1. General Objective

To assess the magnitude and predictive values of preoperative tests for difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia in TikurAnbessa Specialized Hospital from Feb.1- March 30, 2016 Addis Ababa, Ethiopia.

3.2. Specific Objectives

1. To assess the magnitude of difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia in TikurAnbessa Specialized Hospital.
2. To determine the predictive values of preoperative tests for difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia in TikurAnbessa Specialized Hospital.
3. To describe the effect of combining preoperative tests on the validity of predicting difficult laryngoscopy and intubation among surgical patients who underwent elective surgery under general anesthesia in TikurAnbessa Specialized Hospital.

4. Methods

4.1. Study design

A facility based cross sectional study design was used.

4.2. Study area and period

This study was conducted in Addis Ababa University, college of health sciences, TikurAnbessa Specialized Teaching Hospital. This hospital is found in the heart of Addis Ababa and is the largest teaching hospital in Ethiopia having about 800 beds and 17 operation rooms. It provides diagnosis and treatment for 370,000- 400,000 patients per year and approximately 7000 – 9000 patients undergo surgery in a year. The study was conducted from February 1 to March 30, 2016.

4.3. Study Population

4.3.1. **Sourcepopulation:** -all surgical patients who wasunderwentelective Surgery under General Anesthesia

4.3.2. **Study population:** -all surgical patients who was scheduled for elective surgery under general anesthesia with endotracheal intubation

4.4. Eligibility criteria

4.4.1. **Inclusion criteria:**all elective surgical patients scheduled for surgery under GA with endotracheal intubation were included

4.4.2. **Exclusion criteria:**

The following patients were excluded from this study;

- **Patients with known airway difficulty** due to trauma, congenital or acquired abnormalities that compromise the airway.
- **Patients with goiter;** because they are already at increased risk of difficult airway
- **Obstetrics;** due to anatomic and physiological changes of airway during pregnancy predispose them to difficult airway and the use of rapid sequence induction with cricoid pressure may lead to difficult intubation. So, this may affect the validity of preoperative tests.
- **Critically ill patients** in which airway assessment is difficult
- **Age less than 18 years;** because of the anatomic differences of the adult and pediatric airway
- **Psychiatric patients;**because they may not cooperate for the airway assessment.

4.5. Sample size determination

Sample size was determined using finite population correction formula by assuming the prevalence as 0.5 and 5% margin of error at 95% confidence interval using the following formulas:

$$n = \frac{z_{\alpha/2}^2 p(1-p)}{w^2}$$

Where; n = sample size, z= 1.96, p= 0.5, w= 0.05, CI= 95% & α = 5%

$$n = \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} = 384$$

$n_f = n/(1+n/N)$, N = 601 (estimated target population in the study period)

$$\text{So, } n_f = \frac{384}{(1+384/601)} = 234$$

We added **10% of n_f** for nonresponse rate; (i.e., **234+23=257**);

Therefore, a total sample size of **257** elective surgical patients were planned to participate in this study.

4.6. Sampling technique

Since there is no evidence that supports the difference on incidence and predictive values of preoperative tests for difficult laryngoscopy and intubation in seasons or months, we used a consecutive sampling technique. So all eligible patients in the study period were included in this study.

4.7. Study Variables

4.7.1. Dependent variables

- Difficult laryngoscopy
- Difficult intubation

4.7.2. Independent variables

❖ Sociodemographic variables:

- age
- sex
- ASA physical status

❖ Airway related variables (tests):

- Interincisor Distance
- Mallampatti Class
- Thyromental Distance
- Mandibular Protrusion
- Sternomental Distance
- Laryngoscopic grade

❖ Anesthesia related variables:

- Premedication used and its dose
- Drug used for induction and its dose
- Muscle relaxant used and its dose
- Qualification of the anesthetist
- Type and size of laryngoscope
- External laryngeal pressure

4.8. Data collection process and technique

A half day training was given for qualified anesthetists, who was involved in the data collection process. Structured questionnaire was prepared and tested on 5% of the sample size at the actual study area. Informed consent was taken from each patient orally before data collection, then Patients scheduled for elective surgery under GA requiring endotracheal intubation was assessed at the waiting room by the trained data collectors immediately before their entry to the operation room and recorded on the structured questionnaire. Then each patient was observed for difficult laryngoscopy and intubation in the operation room. The Cormack and Lehane's laryngoscopic grade of the patient was determined by the anesthetist who performed the laryngoscopy. Observational data collection technique was used in this study.

4.9. Data quality assurance

Training has given for the data collectors and the questioner was tested on 5% of the calculated sample size. During data collection process there was close supervision of data collectors and collected data was checked every day for its completeness, clarity and consistency by the principal investigator.

4.10. Data analysis

Data with complete information was entered to Epi info version 3.4. Then exported to SPSS version 20 for analysis. The descriptive statistics, binary logistic regression and ROC curve were performed using spss. The association b/n independent factors and the outcome variables were determined by Chi-square, P-value and odds ratio. **The p-value of less than 0.05 was considered as statistically significant.** A binary logistic regression and multivariate analysis were computed to assess the independent predictive factors and strength of association between the outcome and explanatory variables. The validity of parameters (screening tests) such as sensitivity, specificity, odds ratio and 95% confidence intervals were performed using crosstabs on spss, whereas positive predictive values and negative predictive values were calculated manually from the descriptive statistics. The effect of combining different parameters on the validity were also analyzed manually.

4.11. Dissemination and utilization of results

The result will be presented on workshops, Ethiopian Association of Anesthetists Annual Conference, and Scientific Conferences. It will also be discussed with the health managers of TikurAnbessa specialized hospital. Recommendations will be given to the anesthesia professionals and concerned health practitioners depending on the result. Efforts will be made for publication of the result.

4.12. Ethical considerations

Before conducting the study, ethical clearance was obtained from Department of Anesthesia ethical review committee. Then a formal letter detailing the objective of the study was given to the hospital administrators. Then after getting permission from the hospital managers, data collectors obtained informed consentorally from each patient to collect data. During the data collection processnorms, values and morals of patients wererespected by the data collectors.

4.13. Operational definitions

Difficult laryngoscopy: Cormack and Lehane grade III (epiglottis only) or grade IV view (soft palate only)

Difficult intubation: if a trained Anesthetist using direct laryngoscopy takes more than 3 attempts or more than 10 minutes to complete tracheal intubation

General anesthesia: medically induced loss of consciousness, loss of protective reflexes resulting from administration of one or more general anesthetic agents

American Society of Anesthesiologists (ASA) physical status: is a method of categorizing patients' physical state developed by the ASA taskforce which classifies patients according to their physical status (systemic wellbeing). It is classified into six classes:

Class Definition

ASA 1: Normal healthy patient

ASA 2: Patient with mild systemic disease (nonfunctional limitations)

ASA 3: Patient with severe systemic disease (some functional limitations)

ASA 4: Patient with severe systemic disease that is a constant threat to life (functionally incapacitated)

ASA 5: Moribund patient who is not expected to survive without the operation

ASA 6: Brain-dead patient whose organs are being removed for donor purposes

E: If the procedure is an emergency, the physical status is followed by "E" (for example, "2E")

Inter incisor distance (IID): It is the distance between the upper and lower incisors. A value of less than 3 patient's fingers or less than 4cm predicts difficult airway

Mandibular protrusion (MP): the lower incisors can be brought in front of the upper incisors: inability to bring the lower incisors to the upper or mandibular protrusion class B & C suggests difficulty

Mallampatti class (MMC): The Mallampati classification correlates tongue size to pharyngeal size. This test is performed with the patient in the sitting position, head in a neutral position, the mouth wide open and the tongue protruding to its maximum. Classification is assigned according to the extent the base of tongue is able to mask the visibility of pharyngeal structures into four classes, I-IV:

Class I: Visualization of the soft palate, fauces; uvula, anterior and the posterior pillars.

Class II: Visualization of the soft palate, fauces and uvula.

Class III: Visualization of soft palate and base of uvula.

In Samsoun and Young's modification (1987) of the Mallampatti classification, class IV was added.

Class IV: Only hard palate is visible. Soft palate is not visible at all. Mallampatti class III & IV suggests difficult laryngoscopy. Class 3 or 4 suggests a significant chance that the patient will be difficult to intubate.

Thyromental distance (TMD): is defined as the distance from the mentum to the thyroid notch while the patient's neck is fully extended. A value of less than 6cm predicts difficult laryngoscopy or intubation

Sternomental distance (SMD): is the distance from the suprasternal notch to the mentum and measured with the head fully extended on the neck with the mouth closed. A value of less than 12 cm is found to predict a difficult intubation.

Cormack and Lehane laryngoscopic grade: Difficulty in intubation can be classified according to the view obtained during direct laryngoscopy into 4 grades. These 4 grades of laryngoscopic views were defined by Cormack and Lehane (1984):

Grade I – Visualization of entire laryngeal aperture.

Grade II – Visualization of only posterior commissure of laryngeal aperture.

Grade III – Visualization of only epiglottis.

Grade IV – Visualization of just the soft palate.

N.B: Grade III & IV are considered as difficult laryngoscopy and will lead to difficult intubation.

5. Results

Sociodemographic Data and magnitude of difficult laryngoscopy and intubation in the study area

A total of 242 patients (129 male and 113 female) were participated in our study. 15/257 (5.8%) patients were excluded from analysis due to incomplete information.

Patients with ASA physical status I to III and age ≥ 18 years old were included in the study. The mean age of our study population were 38.45 ± 14.869 .

In this study, we found the magnitude of difficult laryngoscopy and intubation as 33/242 (13.6%) and 12/242 (5%) respectively. In this study, difficult intubation was defined as number of attempts ≥ 4 times based on ASA definition. Only two patients took more than 10 minutes to complete endotracheal intubation. There was no cases with failed intubation.

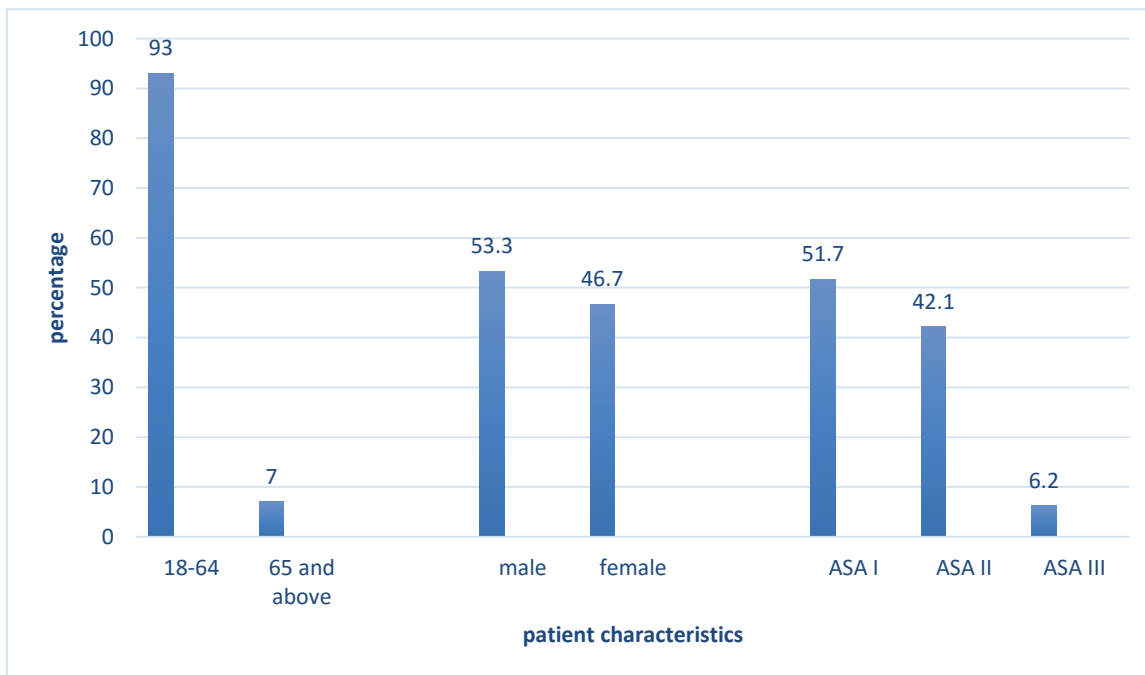


Fig. 1 Sociodemographic characteristics of the study population from Feb. 1 to March 30, 2016.

Table 1: Demographic characteristics and distribution of difficult laryngoscopy and intubation among surgical patients who underwent elective surgery in TikurAnbessa Hospital from Feb. 1to March 30, 2016.

Patient characteristics	Frequency n (%)	DL n (%)	DI n (%)
Age			
18-64	225 (93)	27 (12)	11 (4.8)
≥65	17 (7)	6 (35.3)	1 (5.8)
Sex			
Male	129 (53.3)	18 (13.9)	5 (3.8)
Female	113 (46.7)	15 (13.3)	7 (6.2)
ASA status			
I	125 (51.6)	12 (9.6)	3 (2.4)
II	102 (42.1)	20 (19.6)	7 (6.8)
III	15 (6.2)	1 (6.6)	2 (13.3)

From this table, we can see that the magnitude of difficult laryngoscopy and intubation is higher in the age group of ≥ 65 years. We found an association between age group of patients ≥ 65 years and difficult laryngoscopy (p-value = 0.021 and OR = 3.6 at 95% CI) but not with difficult intubation. ASA class III patients showed an association with difficult intubation (p-value = 0.033 and OR = 2.7 at 95% CI). Sex of the patients has not showed significant association with both difficult laryngoscopy and intubation.

Predictive values of preoperative Tests for Difficult laryngoscopy and Intubation

Table 2: Preoperative airway parameters and their distribution with difficult laryngoscopy and intubation among surgical patients in TikurAnbessa Hospital, from February. 1 – March 30, 2016.

Parameter	Frequency n (%)	DL n (%)	DI n (%)
IID			
< 4cm	56 (23.1)	17 (30.3)	8(14.3)
≥ 4cm	186 (76.9)	16 (8.6)	4 (2.1)
MP			
A	175 (72.3)	15 (8.5)	7 (4)
B&C	67 (27.7)	18 (26.8)	5 (7.4)
MMC			
I & II	214 (88.4)	16 (7.5)	5 (2.3)
III & IV	28 (11.6)	17 (60.7)	7 (25)
TMD			
< 6cm	48 (19.8)	17 (35.4)	7 (14.5)
≥ 6cm	194 (80.2)	16 (8.2)	5 (2.5)
SMD			
< 12cm	36 (14.9)	10 (27.7)	1 (2.7)
≥ 12cm	206 (85.1)	23 (11.1)	11 (5.3)
CL			
I & II	209 (86.4)	0	1(0.47)
III & IV	33 (13.6)	33 (13.6)	11 (33.3)

From the above table, we can see that 60.7% of patients with MMC III & IV were encountered difficult laryngoscopy of which 25% were also difficult for intubation. From the total of 242 patients 33/242 (13.6%) were found to be CL III & IV of which 11 (33.3%) of them were also difficult for intubation.

A binary logistic regression showed that Mallampatti class and thyromental distance as independent predictors for difficult laryngoscopy with p-value=.000 and .017 respectively at 92% Hosmer and Lemeshow test.

Patients with Mallampatti class III & IV have 12.5 times risk to be difficult for laryngoscopy (AOR = 12.5). Similarly, Cormack and Lehane laryngoscopic grade III & IV, Mallampatti class III & IV and sternomental distance less than 12cm were identified as independent predictors for difficult intubation (p-value = .000, 0.031 & 0.008 respectively) at 82.7% Hosmer and Lemeshow test. The adjusted odds ratio for SMD < 12cm, CL = III & IV and MC = III & IV include 48.9, 30.6 and 7.1 respectively at 95% confidence interval.

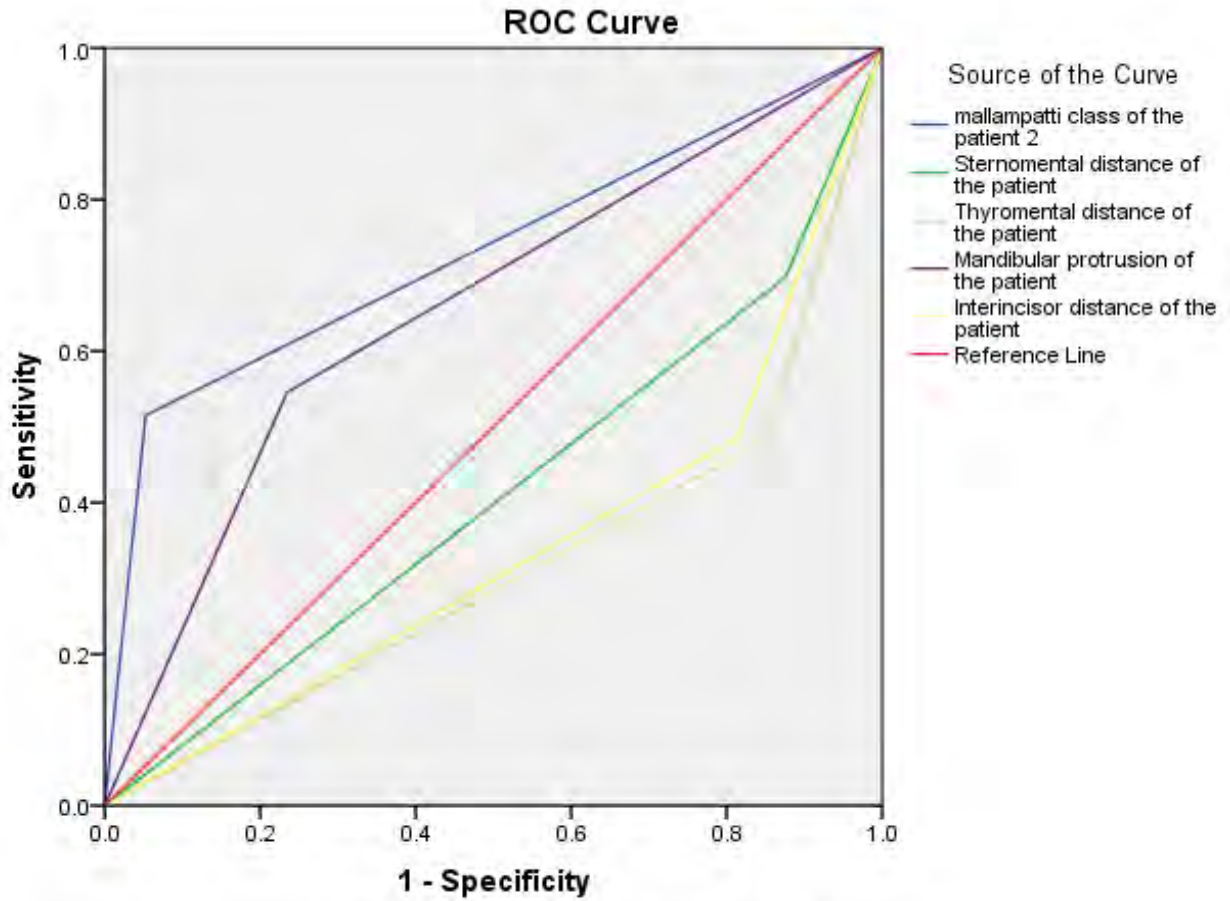
Table 3: Sensitivity, specificity, positive predictive values and negative predictive values for preoperative parameters against difficult laryngoscopy among surgical patients in TikurAnbessa Hospital from February 1 – March 30, 2016.

Parameter	Sn. (%)	Sp. (%)	PPV (%)	NPV (%)	Area	p-value	95%C.I	Accuracy (%)
IID	51.5	81.3	30.35	91.4	0.336	.002	0.228-0.444	33.6
MP	54.5	76.6	26.8	91.4	0.656	.004	0.549-0.762	65.6
MC	51.5	94.7	60.7	92.5	0.731	.000	0.621-0.841	73.1
TMD	51.5	85.2	35.4	91.7	0.317	.001	0.208-0.425	31.7
SMD	30.3	87.6	27.7	88.8	0.411	.099	0.298-0.523	41.1

*P < 0.05, Sn = sensitivity, Sp = specificity, PPV = positive predictive value, NPV = negative predictive value, C.I = confidence interval

From the above table, we can see that Mallampatti class showed greater accuracy (73.1%) followed by mandibular protrusion (65.6%). All tests showed that greater specificity and negative predictive values than sensitivity and positive predictive values respectively. Based on the above table, the receiver operating characteristics curve was used to compare the accuracy of preoperative tests for difficult laryngoscopy.

The ROC curve showed Mallampatti class and mandibular protrusion above the reference line (0.5) with area under the curve of 0.731 and 0.656 respectively.



Diagonal segments are produced by ties.

Fig. 2: Receiver operating curve for preoperative tests against difficult laryngoscopy in the study population

Table 4: Sensitivity, specificity, positive predictive value and negative predictive values for airway parameters against difficult intubation among surgical patients in TikurAnbessa Hospital from February 1 – March 30, 2016.

Parameters	Sn (%)	Sp (%)	PPV (%)	NPV (%)	Area	p-value	95% CI	Accuracy (%)
IID	66.7	79.1	14.3	97.3	0.271	.008	0.112-0.430	27.1
MP	41.7	73	7.4	96	0.574	.391	0.401-0.746	57.4
MMC	58.3	90.9	25	97.6	0.746	.004	0.574-0.918	74.6
TMD	58.3	82.2	14.6	97.4	0.297	.018	0.129-0.466	29.7
SMD	8.3	84.8	27.7	94.6	0.534	.688	0.375-0.694	53.4
CL	83.3	90	30.3	99	0.867	.000	0.742-0.991	86.7

*Sn = sensitivity, Sp = specificity, PPV =positive predictive value, NPV= negative predictive value, C.I=confidence interval, p < 0.05.

In this table, we can see that higher accuracy to predict difficult intubation in laryngoscopic grade III & IV, Mallampatti class III & IV and mandibular protrusion B & C (86.7%, 74.6% and 57.4% respectively). Similar to that of difficult laryngoscopy, preoperative tests for difficult intubation also showed higher specificity and negative predictive values than sensitivity and positive predictive values. Cormack and Lehane laryngoscopic grade III & IV and interincisor distance less than 4cm have showed greater sensitivity (83.3% & 66.7% respectively) when compared to other tests. The receiver operating characteristics curve below, revealed that laryngoscopic grade, Mallampatti class and mandibular protrusion above the reference line (0.5) with the area under the curve of 0.867, 0.746 and 0.574 respectively. The sternomental distance is almost along the reference line with the area under the curve of 0.534.

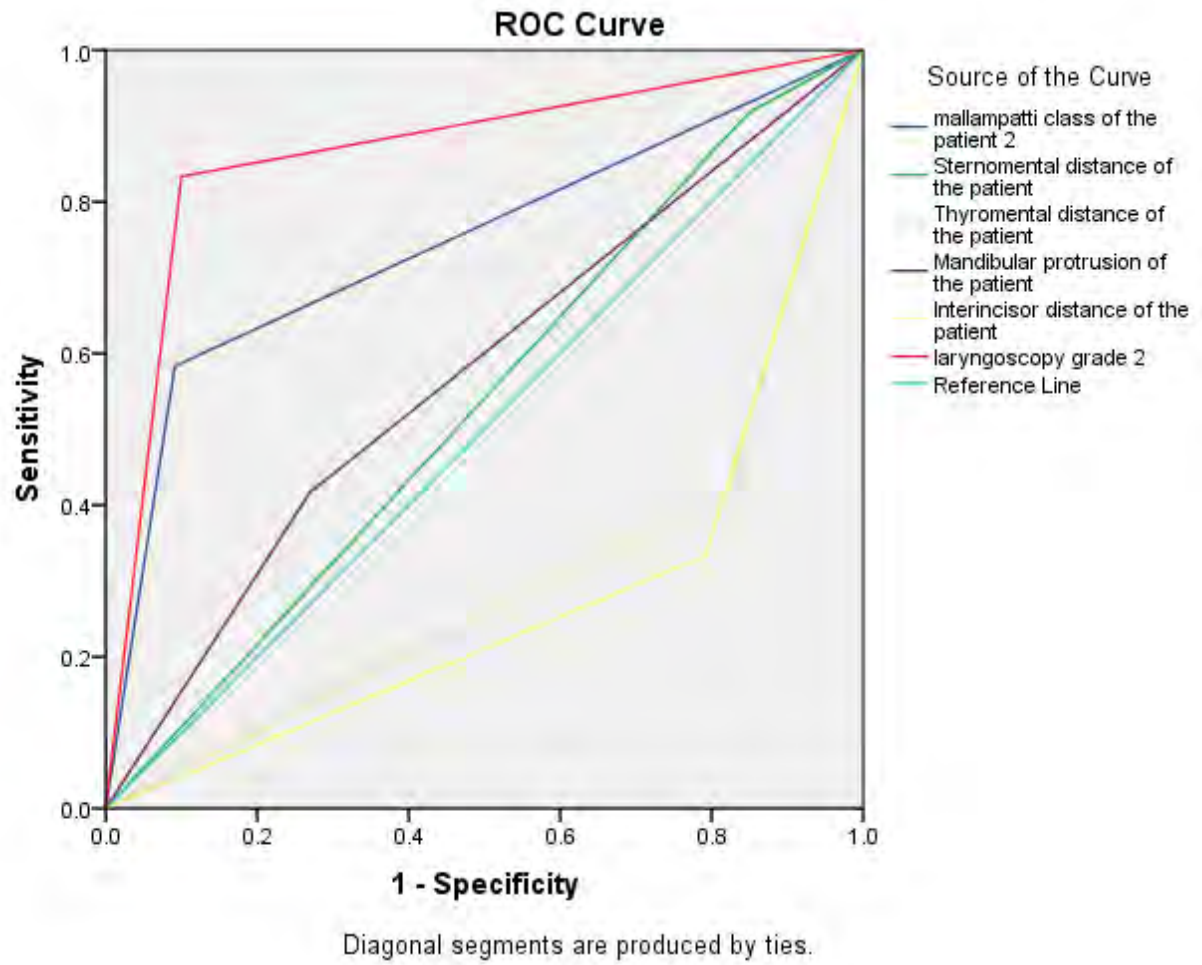


Fig. 3: Receiver operating curve for preoperative tests against difficult intubation in the study population

Combination of two Preoperative Tests to predict difficult laryngoscopy and intubation

Table 5: Sensitivity and specificity of combined preoperative tests for difficult laryngoscopy and intubation among surgical patients in TikurAnbessa Hospital from February 1 – March 30, 2016.

Parameters	Sn (%)		Sp (%)	
	DL	DI	DL	DI
MMC + MP	78	75.6	72.5	66.3
MMC + SMD	66.2	61.7	82.9	77
MMC + TMD	76.4	82.6	80.6	74.7
MMC + IID	76.4	86.1	76.9	71.9
MMC + CL	-	93	-	81.8

Sn =sensitivity &Sp = specificity

From the above table, we can see that combination of MMC and MP tests have higher sensitivity (78%) for DL followed by combination of MMC and TMD or MMC and IID. Combination of MMC & SMD showed higher specificity (82.9%) but, lower sensitivity (66.2%) for DL, whereas MMC + CL has showed the highest sensitivity and specificity for difficult intubation (93% and 81.8% respectively). MMC + IID also showed higher sensitivity (86.1%) for difficult intubation followed by MMC + SMD.

6. Discussion

In this study, we found the magnitude of difficult laryngoscopy and intubation as 13.6% and 5% respectively. Literature review from 1990 to 1996 reported as difficult direct laryngoscopy occurs in 1.5-8.5% of general anesthetics and difficult intubation occurs with a similar incidence (3, 8). Smita et al (4), found 9.7% and 4.5% difficult laryngoscopy and intubation respectively. Iohom G et al (12) and Merah NA et al (13) reported difficult laryngoscopy as 9% and 3.4% respectively. The magnitude of difficult laryngoscopy in our study appeared to be higher compared to the available literatures (3, 4, 8, 12 and 13). The probable explanation for this result may be because of our study was conducted in teaching hospital and most of the intubations were performed by undergraduate students (55%). This may lead to incorrect grading of laryngoscopic view due to lack of skill.

Our finding on the difficult intubation was in line with the above studies and with studies by Savva D. et al (10), Khan ZH et al (14) and Yildiz TS et al (17) who reported as 4.9%, 5% & 4.8% respectively. In contrast to the above findings, Bilgin H & Ozyurt G (18), Keyvan et al (6), Bhavdip et al (7) and Tse et al (9) were reported higher incidence of difficult intubation (8%, 8.24%, 8.1% & 13.1% respectively). This may be because of differences in the population characteristics and differences on the definition of DI, for instance Tse et al and Shiga et al were defined DI as laryngoscopic grade III & IV. But, in our study, we defined DI as number of intubation attempts ≥ 4 times based on ASA definition (1, 2).

In our study, Pearson's correlation showed that a positive correlation between age of patients and difficult laryngoscopy (p-value = 0.021) but not for difficult intubation. In contrast to the difficult laryngoscopy, we found positive correlation between ASA physical status of the patient and difficult intubation with P-value of 0.033. So, according to our study, patients with age ≥ 65 years and ASA III were found to be at higher risk to be difficult laryngoscopy and intubation respectively. A binary logistic regression identified that Mallampatti class and thyromental distance as independent predictors of difficult laryngoscopy with p-value of .000 and .017 respectively at 92% Hosmer and Lemeshow test. Patients with Mallampatti class III & IV have 12.5 times risk to be difficult laryngoscopy (AOR = 12.5 at 95% C.I).

Similarly, we also identified that Cormack and Lehane laryngoscopic grade III & IV, Mallampatti class III & IV and sternomental distance less than 12cm as independent predictors for difficult intubation (p-value = .000, 0.031 & 0.008 respectively) at 82.7 Hosmer and Lemeshow test. The adjusted odds ratio for SMD < 12cm, CL = III & IV and MC = III & IV include 48.9, 30.6 and 7.1 respectively at 95% confidence interval. A multivariate analysis showed that thyromental distance and mallampatti class as an independent predictors for both DL and DI with p-value of (.003 & .000) and (.001 & .000) respectively.

This study is comparable with the study conducted by Smita, et al (4). The mean age of their study was 37.8 ± 13.5 , which is comparable with our study (38.45 ± 14.869). They identified that MC III & IV and IID ≤ 3.5 cm as an independent predictors of difficult laryngoscopy. According to their study, increasing age and male sex have an association with difficult laryngoscopy. Similarly, the study conducted by Yildiz TS. et al (17) in Turkish patients showed an incidence of difficult intubation as 4.8% and increased with age ($P < 0.05$). They found that the incidence of difficult intubation was significantly higher in patients who had a Mallampati III or IV score, a decreased average thyromental and sternomental distance, decreased mouth opening, or decreased protrusion of the mandible ($P < 0.05$). In our study, sex of the patient does not showed association with difficult laryngoscopy and intubation. This finding was in line with the study by Khan ZH et al, there was no significant difference regarding difficult intubation based on gender, whereas there were significant differences between the older tests and laryngeal view ($P < 0.05$, Mc-Nemar test). In contrast to the available literatures, in our study patients with ASA III were appeared to be at greater risk to develop difficult intubation. This may be due to the medical condition of the patient. Savva D. et al (10) conducted a prospective study to predict difficult tracheal intubation on 350 patients and they found difficult tracheal intubation in 17/350(4.9%) patients, which was comparable to our finding. According to Srinivasa S. et al (20) p value was found to be significant with Mallampatti class III & IV, IID, TMD, & SMD for difficult laryngoscopic intubation which is also inline to our study which was in line to our findings, except the IID.

Moreover, our study was also comparable to the study by Khan ZH. et al (14) which was conducted prospectively and showed the prevalence of difficult intubation as 5% (n = 19). Class III upper lip bite test (MP in our case), IID <4.5 cm, TMD <6.5 cm, and SMD <13 cm were defined as predictors of difficult intubation. The only difference between our study and Khan ZH et al was the cut-off points for IID, TMD and SMD. In our study we used lower cut-off points than the study by Khan ZH et al (<4cm, <6cm and <12cm respectively). The reason why we prefer the lower cut-off points were to decrease false positive rates. Different Authors used different cut off points for the preoperative airway tests. This may be because of the difference in the populations' physical appearance and ethnic group (4). So, this suggests that we should have to develop our own cut off points for the airway parameters in our country to predict difficult laryngoscopy and intubation more precisely.

Concerning the predictive values of the independent variables or tests, our study showed that poor sensitivities and positive predictive values but good specificity and negative predictive values for both difficult laryngoscopy and intubation. The sensitivity, specificity and positive predictive values of IID, MMC, MP, TMD & SMD for difficult laryngoscopy in our study showed that (51.5%, 81.3% & 30.35%), (51.5%, 94.7% & 60.7%), (54.5%, 76.6% & 26.8%), (51.5%, 85.2% & 35.4%) and (30.3%, 87.6% & 27.7%) respectively. Similarly, the sensitivity, specificity and positive predictive values of IID, MMC, MP, TMD, SMD and CL for difficult intubation were (66.7%, 79.1% & 14.3%), (58.3%, 90.9% & 25%), (41.7%, 73% & 7%), (58.3%, 82.2% & 14.6%), (8.3%, 84.8% & 27.7%) and (83.3%, 90% & 30.3%) respectively which was comparable to Shiga T et al and most of the available literatures (12, 13, 14, 19). Except the SMD, all tests were statistically significant for DL (p-value < 0.05) at 95% confidence interval, whereas CL has showed greater sensitivity, specificity and positive predictive values for DI followed by IID. MP and SMD showed insignificant p-value (p > 0.05) for difficult intubation even though they have good specificity and negative predictive values. There was limited data that showed the predictive values of preoperative tests for difficult laryngoscopy and difficult intubation separately.

This study is comparable with the study conducted by Iohom G. et al (12), where they found poor sensitivity and positive predictive values for MC, TMD, IID and SMD. Similarly, Merah NA. et al (13) found the sensitivity, specificity and the positive predictive values for the five airway predictors as: MMT (61.5%; 98.4%; 57.1%), TMD (15.4%; 98.1%; 22.2%), SMD (0%; 100%; 0%), HLM (30.8%, 76.0%; 4.3%) and IIG (30.8%; 97.3%; 28.6%) which shows poor sensitivity and positive predictive values but better specificity. According to Shiga T et al (19) Screening tests included were Mallampatti classification, thyromental distance, sternomental distance, mouth opening, and Wilson risk score. Each test yielded poor to moderate sensitivity (20-62%) and moderate to fair specificity (82-97%).

In contrast to the above findings, Srinivasa et al (20), Bhavdip P. et al (7) and Savva D. (10) showed greater sensitivity, specificity and positive predictive values for most of the above tests. This may be due to differences in patients' physical appearance, sample size and cut-off values for the screening tests.

In our study, Mallampatti class showed better accuracy (73.1%) followed by mandibular protrusion (65.6%) for difficult laryngoscopy, whereas Mallampatti class III & IV and Cormack and Lehane laryngoscopic grade III & IV were showed good accuracy for difficult intubation (86.7% & 74.6%) respectively. The available literatures did not showed the predictive value of difficult laryngoscopy for difficult intubation.

Currently available screening tests for difficult intubation have only poor to moderate discriminative power when used alone. So, Combinations of tests add some incremental diagnostic value in comparison to the value of each test alone(21). Literatures have also recommended that the use of combined preoperative measurement parameters in predicting difficult intubation (4, 12, 13, 22, 23).

In a study with a large sample size, researchers noted that the combination of MMT (MMC) and TMD were good predictors of a difficult laryngoscopy in the Thai population (24, 25). They used TMD <6 cm as a parameter as we used in the current study.

Iohom *et al* (7) were also performed a study in Ireland and noted that the validity of positive predictive value of MMT (MMC) increased from 27 to 100% after combining other predictors. The Mallampati test is a worldwide used scoring system for predicting difficult intubation. It has been cited in numerous publications since 1985. It still remains a clinical assessment method for many anesthesiologists despite some controversies on its predictive ability.

In our study, we analyzed the validity of combination of Mallampatti test with other preoperative tests when performed simultaneously to better predict difficult laryngoscopy and intubation. Combination of MMC & MP followed by combination of MMC & TMD/IID showed improved sensitivity for DL (78% & 76.4%) respectively, and Combination of MMC & SMD followed by MMC & TMD showed improved specificity for DL (82.9% & 80.6%) respectively. Combination of MC & CL followed by MMC & IID showed improved sensitivity for difficult intubation (93% & 86.1% respectively), whereas combination of MMC & CL followed by MMC & SMD showed improved specificity (81.8% & 77% respectively). In our study, combination of MMC with MP and MMC with IID/TMD appeared to be more sensitive and best combinations for prediction of difficult laryngoscopy and intubation in our study population. Because of combinations of MMC with TMD/IID showed good sensitivity and specificity for both DL and DI, combinations of MMC, TMD & IID can be more valuable preoperative tests in predicting difficult laryngoscopic intubation. MMC and TMD were also appeared to be independent predictors for both difficult laryngoscopy and intubation in the multivariate analysis in our study.

These findings were in line with the study by Merah NA *et al* (13) who's best combination of predictors were MMT/TMD/IIG with a sensitivity, specificity and positive predictive value of 84.6%; 94.6%; 35.5% respectively. Logistic regression analysis showed that weight, MMT, IIG and TMD were independent predictors of DVL. They concluded that MMT (i.e, MMC), TMD and IIG appear to provide the optimal combination in prediction of DVL in the West African population (13). Bhavdip P. *et al* (7), also suggested that the Combination of MMT (MMC) grading and TMD and SMD measurements increased the validity (sensitivity of 100% and specificity of 92.7%). (7). Iohom G. *et al* (12), suggested that the Mallampati classification, in conjunction with measurement of the thyromental and sternomental distances, may be a useful routine screening test for preoperative prediction of difficult tracheal intubation (12).

Similarly, Shiga T. et al (19), suggested that the most useful bedside test for prediction was found to be a combination of the Mallampati classification and thyromental distance (positive likelihood ratio, 9.9; 95% confidence interval, 3.1-31.9).

On the other hand, Khan ZH et al (14), found the combination of the ULBT(i.e, MP) with SMD provided the highest sensitivity. They concluded that the specificity and accuracy of the ULBT is significantly higher than the other tests and is more accurate in airway assessment. However, the ULBT in conjunction with the other tests could more reliably predict easy laryngoscopy or intubation (14). Our study does not support this conclusion. This might be again because of the effect of physical characteristics of the study population and cut point values. Differences in the definition of difficult intubation may contribute to the difference in the magnitude of DI, this intern may play a role for the variation of predictive values of preoperative tests among different studies as we have seen from the above findings.

Limitations of the Study

The limitations of our study were: 1) Most of the laryngoscopies and intubations were performed by undergraduate students, this might have contribution for higher magnitude of difficult laryngoscopy. 2) Airway management may not follow standard guideline or there may be interpersonal variations in the anesthetic management interms of their experience,preparation and availability of equipment for intubation which may also have an impact on the magnitude of difficult laryngoscopy and intubation. 3) Lack of standardized cut off values for the preoperative airway parameters. Different authors used different cut off values for preoperative tests which can impose some difficulties in comparing different findings.

Conclusion

We found magnitude of 13.6% and 5% for difficult laryngoscopy and intubation respectively, among elective surgical patients with apparently normal airways in TikurAnbessa specialized Teaching Hospital. Increasing age and ASA class III were showed association with difficult laryngoscopy and intubation respectively. Binary logistic regression identified that Mallampatti class and thyromental distance as an independent predictors for difficult laryngoscopy with p-value=.000 and .017 respectively. Similarly, laryngoscopic grade III & IV, Mallampatti class III & IV and sternomental distance less than 12cm were identified as an independent predictors for difficult intubation (p-value = .000, 0.031 & 0.008 respectively). A multivariate analysis identified Mallampatti class and thyromental distance as an independent predictors for both difficult laryngoscopy and intubation with p-value of (.003 & .000) and (.001 & .000) respectively.

The sensitivity and positive predictive values of individual preoperative tests appeared to be poor, but showed good specificity and negative predictive values. The ROC curve revealed that better accuracy with Mallampatti class and mandibular protrusion to predict difficult laryngoscopy with the area under the curve of 0.731 & 0.656 respectively at 95% confidence interval. Similarly, Mallampatti class and laryngoscopic grade showed more accuracy to predict difficult intubation with the area under curve of 0.746 & 0.867 respectively. Combination of MC with IID/TMD/CL showed improved sensitivity and specificity, and found to be better combinations to predict difficult laryngoscopy and intubation.

Recommendations

In spite of various airway assessment tests no single test was 100% accurate. So it is advisable to use combination of different tests.

We would like to recommend anesthesia professionals to use the combination of MC/TMD/IID as their routine preoperative tests to predict difficult laryngoscopic intubation.

Anesthesia professionals should develop guideline for preoperative airway assessment to decrease incidence of difficult laryngoscopy and intubation. Further multicenter study should be conducted in this particular topic to develop national guideline for preoperative airway assessment.

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Annexes

I. Consent Form

Addis Ababa University, College of Health Sciences Department of Anesthesia

Magnitude and Predictive Value of Preoperative Tests for Difficult Laryngoscopy and Intubation among Surgical Patients who underwent elective Surgery under General Anesthesia in TikurAnbessa Specialized Hospital from Feb.1- March 30, 2016.

Introduction

My Name is..... , I work for

This questionnaire is to assess the magnitude and predictive value of preoperative tests for difficult laryngoscopy and intubation among surgical patients of TikurAnbessa Specialized Hospital. The main concern of this study was to fill the information gap on the magnitude and predictive value of preoperative tests for estimating difficult laryngoscopy and intubation which can contribute to improve perioperative patient management and decrease anesthesia related morbidity and mortality. So you are kindly requested to participate on this study and provide appropriate response to questions. We obtained your name from the list of appointed surgical patients. Your participation is voluntary. Only anonymous data will be analyzed and we strictly keep confidentiality of participants. Participating or not participating on this study will not bring any harm or benefit to you. This interview will take a maximum of 15 minutes. Therefore we kindly request you to respond for the following questions based on your willingness. If you feel or face any problem regarding your participation, you can contact the principal investigators by 0913724684.

Can I proceed? Yes ----- No -----

Thank you for your participation!

የአማርኛ ጥያቄ ቅጽ

ሰላም፣ እኔ _____ እባላለሁ። የምሰራው ነው።

በቀዳሚያ ጊዜ የሰሙ መንገድ ሲጀምር የአየር ባንቢ ተኮኮማ ስንገባ ተገቢ ተያይዞ የሚፈጠር የአየር ባንቢ ጥገና ላይ ጥናት በማድረግ ላይ እንገኛለን።

እኔም የቡድኑ አንድ አካል ነኝ። የተመደበው ሀኪም የአየር ባንቢ ተኮኮማን በተገቢው የአካል ክፍል ሲያስገባ የዚህ ጥናት አላማ የችግር ንስፋትና አጋላጭ ነገሮችን ለማወቅ ነው።

ይህ ጥናት የበሽተኛውን ደህንነትና የችግሮቹን አስከፊነት ለመቀነስና አጋላጭ ምክንያቶችን እንዲሁ ምን ምን ጥገና ልቀቅና አሳሳቢ ንትቦ ስፒታሉ ለማሳወቅ ነው።

በዚህ ጥናት ሂደት ውስጥ የሚሰበሰቡ ማንኛውም አይነት መረጃ ሙሉ በሙሉ በምስጢር የሚጠበቅ መሆኑን ልናረጋግጥ ልቻለን ወዳለን። የማንኛውም ተሳታፊ ስም ከግምት ውስጥ የማይገባ የሚሰጡት ምንኛውንም መረጃ ለማንም ተላልፎ እንደማይሰጥ ብሎ ምንም ዓይነት ጤን እርሶን በስም እንደማይለይ ወይም ሌላ ጥገና ላይ ለማሳወቅ ነው።

መጠይቁ በፈቃደኝነት ላይ የተመሰረተ ሲሆን እርሶን በዚህ ጥናት ላይ የመሳተፍ ሙሉ ሙሉ ብትክ አለዎት። ይህም ብቻ ሳይሆን ከጀመሩ በኋላ ምንኛውም ጊዜ ማቋረጥ እንዲሁ ምንም ሙሉ በሙሉ ያለ መሳተፍ ብትክ አለዎት።

መቀጠል እችላለሁ፤

- 1. አዎ ይቻላል
- 2. አይቻልም

Informed consent Certified by
 Name _____ signature _____
 Date of data collection _____
 Questionnaire identification number _____

II. Questionnaire

Part I: Identification

Code No Age:..... yrs Sex: male female
ASA status: I II III IV V

Part II: Airway characteristics

1. Interincisor distance: A. less than 4cm/ 3 patients' fingers B. greater than or equal to 4cm/ 3 patient's fingers
2. Mallampatti class: I II III IV
3. Mandibular protrusion: A B C
4. Thyromental distance: A. less than 6cm B. greater than or equal to 6cm
5. Sternomental distance: A. less than 12cm B. greater than or equal to 12cm
6. Cormack &Lehane laryngoscopic grade: I II III IV
7. External laryngeal pressure: A. applied B. not applied
8. Number of attempts for intubation: I II III IV
9. Time taken to intubate the patient: A. less than 10 minutes B. greater than or equal to 10 minutes
10. Intubation : A. Failed Successful
11. Qualification of the anesthetist who performed the intubation: A. under graduate student
B. Msc in Anesthesia student C. Bsc Anesthetist D. Msc Anesthetist E. anesthesiology resident F. Anesthesiologist

Part III: Anesthetic Technique

1. Premedication used Not used.....
2. Drug used for induction and its dose
3. Drug used for muscle relaxation and its dose
4. Type and size of laryngoscopy blade
5. External laryngeal pressure: A. applied B. not applied

III. ROC Curve

The ROC curve is a graph of sensitivity (y-axis) vs. $1 - \text{specificity}$ (x-axis). The curve is created by plotting the true positive rate against the false positive rate at various threshold settings. The true-positive rate is also known as sensitivity. The false-positive rate is also known as the fall out and can be calculated as $1 - \text{specificity}$.

The accuracy of the test depends on how well the test separates the group being tested into those with and without the condition of interest.

The diagonal line $y = x$ represents the strategy of randomly guessing a class. This reference line is a random classifier which produce a ROC point that “slides” back and forth on the diagonal based on the frequency with which it guesses the positive class. It is also known as line of equality or random chance line.

Accuracy is measured by the area under the ROC curve (AUC). ROC curve areas are typically between 0.5 and 1.0. An area of 1 represents a perfect test; an area of 0.5 represents a worthless test.

Simple guide for classification ROC curve areas:

- .90-1 = excellent (A)
- .80-.90 = good (B)
- .70-.80 = fair (C)
- .60-.70 = poor (D)
- .50-.60 = fail (F)

IV. Declaration

I, the undersigned, declare that this thesis is my original work in partial fulfilment of the requirements for the degree of MSc in Anesthesia. I understand that plagiarism will not be tolerated and all cited materials has been appropriately referenced.

Name: _____

Signature: _____

Submission to the Dept. of Anesthesia, Addis Ababa University.

Date of Submission: _____

This thesis work has been submitted for examination with my/our approval as Advisor on the MSc in Anesthesia course.

Name

Signature

1.

2.