COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF ANESTHESIA

Magnitude and Associated Factors of Difficult Airway in Adult Patients Who Underwent Elective Maxillofacial Operation with Endotracheal Intubation at Selected Public Hospitals, Addis Ababa, Ethiopia, 2021: Cross-sectional study.

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Title	**Magnitude and Associated Factors of Difficult Airway in Adult Patients Who Underwent Elective Maxillofacial Operation with Endotracheal Intubation at Selected Public Hospitals, Addis Ababa, Ethiopia, 2021: A cross-sectional study.**
Study period	**January 22/2021 to May 21/2021**
Study area	**At selected public hospitals, Addis Ababa, Ethiopia**
Total cost of project	**28,188.600 Eth. Birr.**

Abstract

Background: Difficult airway is a phenomenon in which there is a problem in maintaining gas exchange via a mask, an artificial airway or both. Degree of difficulty is associated with patient's airway anatomy and health status, clinical settings, surgical procedures that are being performed and experience of the practitioner. It results morbidity and mortality specifically in developing countries where equipment that aids for difficult airway management is not accessible.

Objective: To assess magnitude and associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021: A cross-sectional study.

Methods: A cross-sectional study was conducted from January 22/2021 to May 21/2021 on 208 participants at three selected public hospitals in Addis Ababa that provide maxillofacial surgery. Hospitals were selected purposively. A review of logbook showed that 216 patients underwent surgery in four consecutive months before data collection process. Actual study participants who met inclusion criteria were (n = 208). Data were analyzed using SPSS version 24. Binary and multivariate logistic regression were used to measure association between the factors and outcomes at 95% CI using AOR. P value below 0.05 was considered as statistical significance.

Results: A total of 208 participants were investigated. We found that magnitude of difficult airway, difficult laryngoscopy, difficult intubation, difficult mask ventilation and failed intubation were 23.1%, 17.8%, 16.3%, 5.3 and 0.96% respectively, but there were no cases with 'Can't Ventilate Can't Intubate' situation. Upper lip bite test class III, oropharyngeal view class IV, sternomental distance below 12cm, thyromental distance below 6cm, body mass index above 30kg/m^2, age above 55 years and history of snoring were an independent predisposing factors for difficult airway.

Conclusion and Recommendations: The extent of the problem was considerably high; thus, we recommend anesthesia providers and hospital administrators to give emphasis. Availability of fully equipped facilities, appropriate use of alternative techniques and laryngeal manipulation are highly recommended to decrease the incidence.

Keywords: Difficult airway; Maxillofacial surgery, Associated factors.

Declaration

The under signed certify that the research entitled magnitude and associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021: A cross-sectional study is my original work and any literature and/or data cited in this article were listed in the reference section and any assist done during this period has been given an acknowledgement.

Investigator

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Approval of the Board of Examiners

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Finally, I would like to provide my gratitude to study participants and all the data collectors who worked in each hospital.

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Acronyms

ASA	American societies of Anesthesiologists
BSC	Bachelor of science
BLSH	Black Lion Specialized Hospital
CICV	Can't Intubate Can't Ventilate
CI	Confidence Interval
DA	Difficult Airway
DI	Difficult Intubation
DMV	Difficult Mask Ventilation
FI	Failed Intubation
IIG	Inter incisal gap
IDS	Intubation difficult score
JS	Jaw slide
MSC	Master of Science
OPV	Oropharyngeal view
SPHMMC	Saint Paulo's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science
ULBT	Upper Lip Bite Test

CHAPTER ONE: INTRODUCTION

1.1 Background: Maxillofacial surgery is surgical specialty which focuses on problems concerning the face, jaw, dental and mandibular procedures (1). Currently, maxillofacial surgeries are more advanced than before as researches and technologies continue to grow. These leads to an increase in the number of hospital admissions of maxillofacial patients, which intern increases the challenges of difficult airway to anesthesia providers (2). The main challenges are difficulties in securing the airway and airway sharing (3).

Nowadays, there is no universally accepted definition of difficult airway in available literatures, instead it consists of factors including inadequate or impossible facemask ventilation, inability to visualize vocal cords with laryngoscope, difficulty or inability to intubate with standard endotracheal tubes (4).

ASA defined difficult airway as the clinical situation in which a trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both (5).

Laryngoscopy is direct or indirect visualization of larynx to pass tracheal tubes. Direct one involves using rigid laryngoscope to view laryngeal structures under direct vision whereas indirect one is insertion of endotracheal tube by a method of indirectly visualizing vocal cords either using video camera or fiber optics (6).

Tracheal intubation with direct laryngoscopy is the gold standard technique for securing airway in maxillofacial surgical patients. However, it is expected to be more difficult in these group of patients (7). Difficulties in tracheal intubation arises from anatomical, physiological or both aspects. Anatomically difficult intubation refers to difficult airway which involves challenges in viewing vocal cords or passing a tube in to the trachea whereas physiologically difficult intubation refers to difficult airway that involves cardiopulmonary compromise, manifested as hypoxemia or hypotension (8).

Associated factors for difficult airway in maxillofacial patients can be seen from different perspectives. It can be related to patient factors, clinical skill of anesthesia provider, clinical settings and underling pathology (9).

1.2 Statement of the problem

Patients admitted for maxillofacial surgery present complex challenges for anesthesia provider because they have compromised airway. The commonest challenge is difficulty to secure the airway for effective ventilation (1). It arises mainly from problems like ventilatory mask may not fit properly to the face for effective mask ventilation, viewing vocal cords using direct laryngoscope and tracheal intubation may also be difficult because oropharynx's anatomy could be disarranged by trauma or disease (7).

During anesthesia, patent airway is vital for adequate oxygenation and ventilation. A delay to secure the airway even for a few minutes result in patient death (10). In areas where maxillofacial procedures were done, majority of the cases required invasive ventilation. Failure to secure the airway results in deleterious consequences such as brain damage, cardiac arrest and death of 16% inpatients from hypoxia (11).

Difficult airway either anticipated or unanticipated is a major cause of respiratory related injuries during perioperative period. Patients with a disease involving maxillofacial region have higher respiratory complications than the general population, 15.8% Vs 8.5% respectively (8,12).

Difficult airway is the major cause of death in maxillofacial patients and about 600 patients die each year in developed countries from its consequences, which is much catastrophic in developing world (7).

Airway trauma is the major complication of difficult airway because it involves application of more physical force during instrumentation than is normally used with the reported consequences , 4.1% to 28% (13,14).

World widely, the magnitude of difficult airway in maxillofacial surgical patients who required endotracheal intubation varied from 11.76% to 32% (10).

1.3 Justification of the study

Determination and identification of magnitude and associated factors of difficult airway in maxillofacial surgeries is the first important event to take appropriate intervention.

Several studies done outside Ethiopia showed that the prevalence of difficult airway was much higher in maxillofacial patients than the general surgical patients. But those studies were conducted in developed countries where an equipment that needed for difficult airway is accessible.

In Ethiopia, as far as our search, there are no available data on magnitude and associated factors of difficult airway in maxillofacial surgical patients. This may show less attention was given for the problem. So, our knowledge regarding this is relied on researches done in other countries.

The findings of many studies on determining magnitude and associated risk factors of difficult airway were inconsistent with each other due to variety in patient characteristics, terms they used to define difficult airway and types of study design applied.

As magnitude and associated factors of the problem was not well known in the study areas and the remaining part of the country, the result will help anesthetists, maxillofacial surgeons and institutional administrators to give emphasis on the extent of the problem and factors associated to it. The findings will also help to minimize anesthesia related morbidity and mortality through taking immediate actions.

Furthermore, it will also recommend institutions to fulfil materials that are needed to manage difficulties and may be used as a base line data for other researchers to investigate further on it.

CHAPTER TWO: LITERATURE REVIEW

2.1 Magnitude of difficult airway

Difficult airway which can be due to difficult or impossible mask ventilation, poor view of the vocal cords on laryngoscopy or difficulty in securing the airway with endotracheal tube is challenging for anesthesia providers, maxillofacial surgeons, ear nose and throat surgeons , general surgeons and other healthcare physicians (15).

Globally, there were many researches done on the incidence of difficult airway. The magnitude of difficult airway in available literatures widely varied, ranged from 11.76% to 32% (7).

A prospective multicentered cross sectional study conducted in Thailand (2010) on 1996 patients aged from 17 years and above undergoing maxillofacial surgery showed that the incidence of difficult airway that required general anesthesia with endotracheal intubation was 15.38% (8).

A prospective cross sectional conducted in China (2013) on 116 elective maxillofacial surgical patients aged from 16 to 78 years showed that the overall incidence of difficult airway was 15.4% (16).

A similar study conducted in Singapore (2016) also showed that the incidence of difficult intubation had been shown to be higher in maxillofacial patients than the general surgical patients with magnitude of 15.75% vs 2.5% respectively (17).

A retrospective study conducted in Japan on 14,195 maxillofacial surgical patients aged from 3 months and above investigated that the magnitude of difficult airway that included difficult mask ventilation, airway obstruction after induction of anesthesia and difficult laryngoscopy were 16.9% (12).

Mask ventilation is the most important airway management skill in case of failure to the initial intubation attempt that can be given before or after intubation failure or both (1). However, in patients with maxillofacial tumors or fractures , mask sealing is difficult and results in severe gas leakage, desaturation and death (18).

The reported incidence of difficult mask ventilation in Asian countries who underwent maxillofacial procedures varied widely from 0.9% to 15% (9).

A retrospective study conducted in Texas medical center, USA (2014) on 1399 patients showed that 8.9% patients were found to have difficult mask ventilation (19).

A multi-center prospective cross sectional study conducted in France on 1,052 patients for six months of duration to determine the predictive values of difficult mask ventilation on adult elective patients found that magnitude of difficult mask ventilation was 5% (20).

Direct laryngoscopy and tracheal intubation are the most commonly used techniques as part of general anesthesia or during resuscitation efforts. But, these group of patients have temporomandibular joint illness or facial abnormalities so that visualization of the glottis and tracheal intubation can be difficult or impossible (21).

A prospective cross sectional study conducted in Turkey (2008) on 208 patients investigating that the incidence of difficult intubation was 15.4% (22).

A similar study conducted in India (2014) on 68 elective maxillofacial surgical patients showed the incidence of difficult intubation was 11.76% (7).

A comparative cross sectional study conducted in Japan (2016) on 28 patients who had previous history of major head and neck surgery found that the incidence of difficult intubation was 33.3% (23).

A prospective cross-sectional study was conducted in Great Britain (2012) on 644 adult patients scheduled for elective maxillofacial surgery. They showed that the incidence of difficult intubation was 15.4% with high incidence (21%) in males and low (10.2%) in female patients (24).

2.2 Associated factors for difficult airway

Several factors like patient characteristics, clinical setup and experience of anesthesia provider have its own impact while securing the airway. Workeneh et al (2017) conducted hospital based cross sectional study on 212 patients at Gondar University Hospital to assess magnitude and predisposing factors of difficult airway during induction of general anesthesia found that ineffective alternative techniques had increased predictability value of difficult airway (25).

Maier et al (2006) stated that limited mouth opening, inability to bring the lower incisors to the upper incisors, inability to bite the upper lip with the lower teeth, previous neck and head region surgery were predisposing factors for difficult airway (26).

Evans et al (2018) described that obesity, age above 55 years, history of snoring, Mallampati class IV and protrusion tests were all independent predictors of difficult mask ventilation (11).

A prospective cross sectional study conducted in Turkey (2005) on 576 patients found that mallampati class IV, male patients, history of snoring, increasing age and increasing weight were found to be risk factors for difficult mask ventilation (27).

A comparative study conducted by Cattano et al (2014) on 1399 patients assessed risk factors for difficult airway. They stated that age, body mass index , previous surgery to head and neck region and interdental distance below 4cm were statistically significant (19).

A cross sectional study conducted by Phero et al (2013) stated that male sex, high Mallampati classification, history of snoring and decreased thyromental distance were suggestive of difficult airway (28).

Afshari et al (2014) also identified Mallampati class, mouth opening , thyromental distance, sternomental distance and protrusion of mandible were associated with difficult airway (18).

A comparative cross-sectional study conducted in Minnesota, USA on 725 patients showed diabettes melittes was an independent risk facctor for difficult airway (29).

A cross sectional study conducted by Ataro et al (2016) on 120 consecutive patients stated that BMI and age had no significant association with difficult airway (30).

Tamir et al (2019) conducted a cross sectional study on 257 electively scheduled adult patients at Black Lion Specialized Hospital identified predictive values of preoperative tests for difficult laryngoscopy and intubation. They stated that sex of patients did not show significant association with both difficult laryngoscopy and intubation (31).

2.3 Conceptual frame work

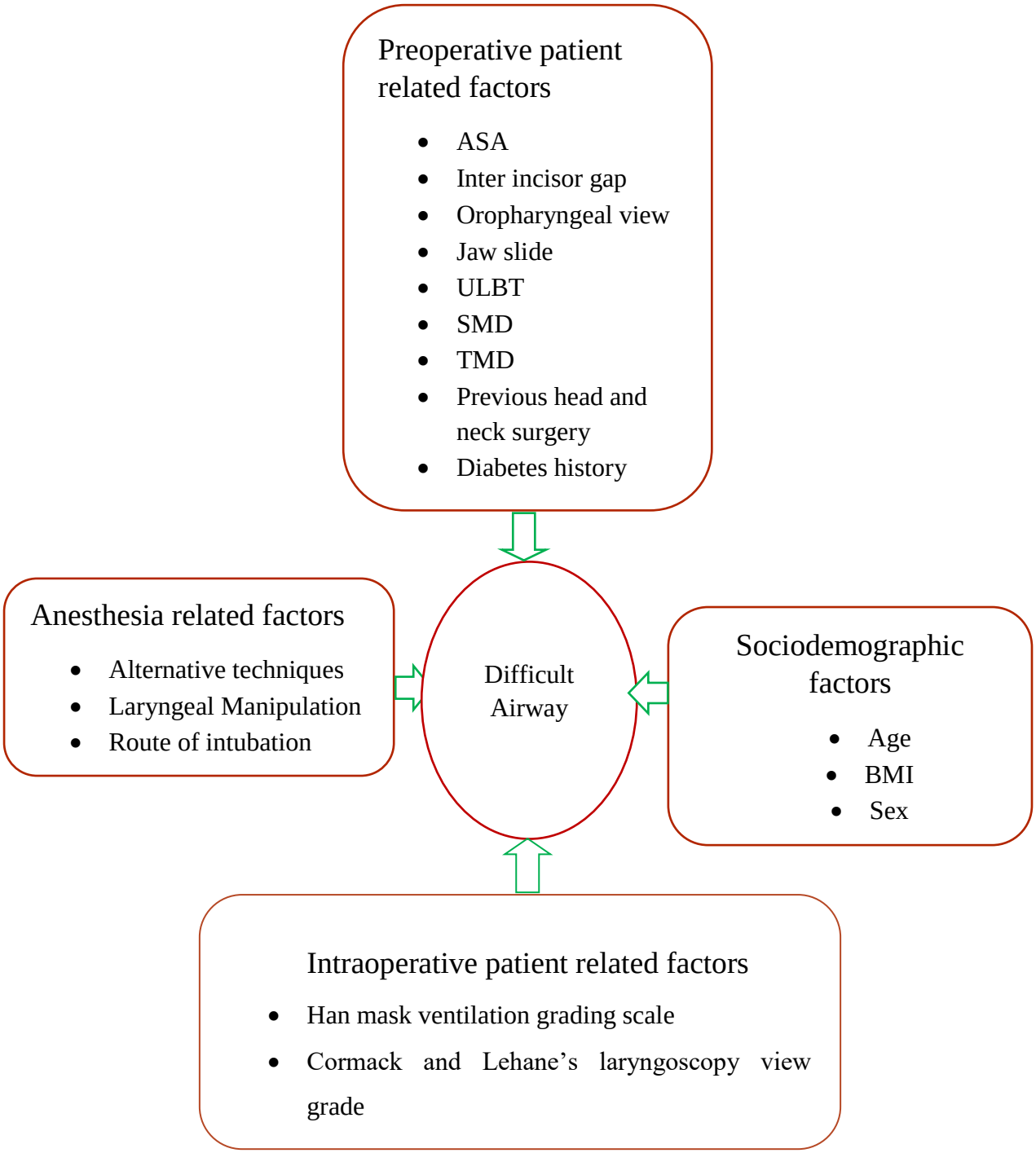

Figure 1: The relationship between difficult airway and its associated factors.

CHAPTER THREE: OBJECTIVE

3.1 General Objective

- To assess magnitude and associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021.

3.2 Specific Objectives

- To assess magnitude of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021.

- To identify associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021.

CHAPTER FOUR: METHODS AND MATERIALS

4.1 Study Area

The study was conducted in Addis Ababa, the capital city of Ethiopia with average elevation of 2500 meters above sea level. The city has a geographic and territorial possession with an area of 540sq. km. There are 79 government owned health facilities in the city: 13 hospitals, 23 health centers, 9 clinics and 34 health posts. Out of thirteen hospitals, five of them provide maxillofacial surgical procedures. These are: Saint Paulo's Hospital Millennium Medical College, Yekatit12 hospital, Black lion Specializes Hospital, St. Peter and Menelik II hospitals. The study was conducted at three hospitals namely: Black Lion Specialized Hospital, Saint Paul's Hospital Millennium Medical college and Yekatit12 hospital. These hospitals were selected purposively because there was low patient flow in other hospitals.

4.2 Study design and Study period

A cross-sectional study design was conducted from January 22/2021 to May 21/2021.

4.3 Population

4.3.1 Source of population: All adult elective maxillofacial patients during the study period at selected public hospitals, Addis Ababa, Ethiopia.

4.3.2 Study Population: All adult maxillofacial patients who underwent elective surgeries under general anesthesia with endotracheal intubation and fulfilled inclusion criteria at selected public hospitals, Addis Ababa, Ethiopia.

4. 4 Inclusion and exclusion criteria

4.4.1 Inclusion criteria

All adult elective maxillofacial patients under ASA class I, II and III who underwent general anesthesia with endotracheal intubation under conventional laryngoscopy.

4.4.2 Exclusion criteria

- Patients with preoperative pulse oximetry oxygen saturations below 92%
- Patients who had goiter

4.5 Sample size and sampling technique

All participants who fulfill inclusion criteria at selected public hospitals were included, hence no sampling technique was used. A situational analysis showed that within the last four months before data collection began, a total of 216 adult elective patients underwent maxillofacial operations with endotracheal intubation. The number of surgical procedures performed at Saint Paul's Hospital Millennium Medical College, Yekatit12 hospital and Black Lion Specialized Hospital during the study period were 128, 64 and 24 respectively.

Eight patients were excluded in our study because three of them didn't full fill inclusion criteria and five of them had incomplete data.

4.6 Data collection tool and procedure

Data was collected from January 22/2021 to May 21/2021. A questionnaire for difficult airway assessment was prepared in English then translated to Amharic and was used as a data collection instrument. During data collection period, three BSc anesthesia professionals involved and one MSc holder supervised for the data collection process. Data collectors were from other hospitals where data collection process did not take place. Training about how to collect data and airway assessment parameters was given for anesthetists who involved in the data collection process. After receiving patients into preoperative waiting area; they were assessed by the data collectors on the sociodemographic characteristics, ASA class and preoperative airway status. Airway parameter measurements were obtained using a rigid ruler. Weight and height of patients were measured with standard instrument called balance scale.

Once the patient entered into the operation theatre, data collectors observed and filled questioner for difficult mask ventilation, difficult laryngoscopy and difficult or failed intubation after induction of general anesthesia. Mask ventilation, laryngoscopy view and intubation were assessed using Han mask grading scale, Cormack and Lehane's laryngoscopy view grade and Intubation Difficult Score respectively. Cormack and Lehane's laryngoscopy view grade and position of vocal cords either opened or closed were determined by the anesthesia provider who performed laryngoscopy.

4.7 Study variables

4.7.1 Dependent Variable

- Difficult airway

4.7.2 Independent variables

1. Socio demographic variables

- Age
- Sex
- BMI

2. Perioperative patient related Variables

- ASA
- Inter incisor gap
- Oropharyngeal view
- Jaw slide
- Ability to bite upper lip with lower teeth
- Thyromental distance
- Sternomental distance
- History of surgery to neck and head region
- History of diabetes mellites
- History of snoring

3. Anesthesia related factors

- Alternative techniques applied
- Laryngeal pressure applied
- Routes of intubation

4.8 Operational Definition

Difficult airway: it is when experienced anesthesiologist or anesthesia provider encounters difficulty with any or all of the followings: face mask ventilation, laryngoscopy or tracheal intubation.

IID: A distance between upper and lower incisors. A value greater than 3 patient's fingers or greater than 4.5 cm is considered as normal.

TMD: A distance measured between mentum and thyroid notch while the patient fully extends his/her neck. A distance greater than 6 cm is considered as normal.

SMD: A distance measured between suprasternal notch and mentum while neck is fully extended. A value greater than 12 cm is considered as normal.

Difficult face mask ventilation: Mask ventilation requiring the need of oxygen flush valve more than twice or performing a two-handed mask ventilation or operator changes with or without muscle relaxants.

Han mask ventilation grade III is considered as difficult mask ventilation.

Difficult laryngoscopy: It is defined as the presence of Cormack and Lehane Grade III or IV or when experienced anesthesiologist or a trained anesthesia provider performing laryngoscopy visualizes only the epiglottis or just the soft palate with multiple attempts using conventional laryngoscope.

Difficult tracheal intubation: if experienced anesthesiologist or anesthesia provider using direct laryngoscopy encounters difficult intubation in the presence or absence of tracheal pathology. Intubation Difficult Score of 0 is considered as easy intubation whereas Intubation Difficult Scores between 0 and 5, above 5 and ∞ were considered as slight difficulty, moderate to major difficulty and failed intubation respectively.

Failed intubation: Inability to intubate the tracheal with multiple attempts. Intubation Difficult Score of ∞ is considered as failed intubation.

Can't ventilate can't intubate situation: Inability to ventilate and intubate the patient or Han mask ventilation grade IV and Intubation Difficult Score of ∞.

4.9 Data processing and analysis

Data were checked manually for completeness and then coded and entered into epi info version 7 computer program for cleaning. It was then exported to SPSS version 24.0 computer program for analysis. Descriptive statistics like frequency was used to summarize data, tables and figures. Bivariate and multivariable logistic regression model were carried out to examine the

effect of explanatory variables over the outcome variable. The variables which were significant on bivariate analysis at p- value less than 0.2 were taken into multivariable analysis. In multivariable analysis p-value of less than 0.05 was used as a cut of point for presence of association. Strength of association was measured by 95% confidence interval and Odds ratio. The result was then presented by using texts, tables, charts and graphs.

4.10 Data quality control

Data collectors and supervisors were trained on each item included in the study tools, objectives, relevant of study and right of respondents. Pretest was also done on 5% of study participants. During data collection, regular supervision and follow was made. Investigator cross checked for completeness, accuracy and clarity of data on daily basis.

4.11 Ethical consideration

The study was conducted after approval by Addis Ababa University Ethical Review Board. A legal letter was submitted to hospitals where study was conducted. After getting permission from hospitals and study participants, data collection process began. Verbal informed consent was also obtained from all participants after full explanations of the goals of the study. Confidentiality and anonymity were ensured at all times.

4.12 Dissemination of Results

The result of the study will be submitted to the collage health sciences of Addis Ababa university, study hospitals and Ethiopian Anesthetist Association Board. The result will be presented at college of health sciences in different seminars, meetings, conferences and workshops. Moreover, efforts will be done to publish the findings of the study through different local and international journals.

CHAPTER FIVE: RESULTS

5.1 Sociodemographic characteristics and magnitude of difficult airway

A total of 216 adult elective maxillofacial patients were operated under general anesthesia with endotracheal intubation during the study period. Eight patients were excluded from analysis due to inconsistence response with a response rate of 96.3%. The mean age of participants was 35.33±13 with minimum and maximum values of 18 and 76 years respectively (**table 1**). The magnitude of difficult airway and failed intubation were 23.1% and 0.96% respectively. Two patients who had failed intubation were postponed to the next day for surgery under tracheostomy, but of all difficulties that encountered, there were no cases with 'CICV' situation (**figure2**).

Table 1: Socio demographic characteristics of adult study participants who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021 (**n = 208**).

Variables	Category	Frequency (n), Percentage (%)	Difficult airway: Frequency (n), Percentage (%)	
			Yes	No
Sex	Male	116 (55.8)	31 (26.7)	85 (73.3)
	Female	92 (44.2)	17 (18.48)	75 (81.52)
Age (years)	18-35	116 (55.8)	17 (14.6)	99 (85.4)
	36-55	62 (29.8)	19 (30.6)	43 (69.4)
	Above 55	30 (14.4)	12 (40.0)	18 (60)
ASA	ASA I	152 (73.1)	19 (21.7)	133 (78.3)
	ASA II	38 (18.3)	15 (23.7)	23 (76.3)
	ASA III	18 (8.6)	14 (33.3)	4 (66.7)
BMI (Kg/m^2)	Below 18.5	24 (11.5)	3 (12.5)	21 (87.5)
	18.5-24.9	148 (71.2)	29 (19.6)	119 (80.4)
	25-29.9	31 (14.9)	12(42)	19 (58)
	Above 30	5 (2.4)	4 (80)	1 (20)

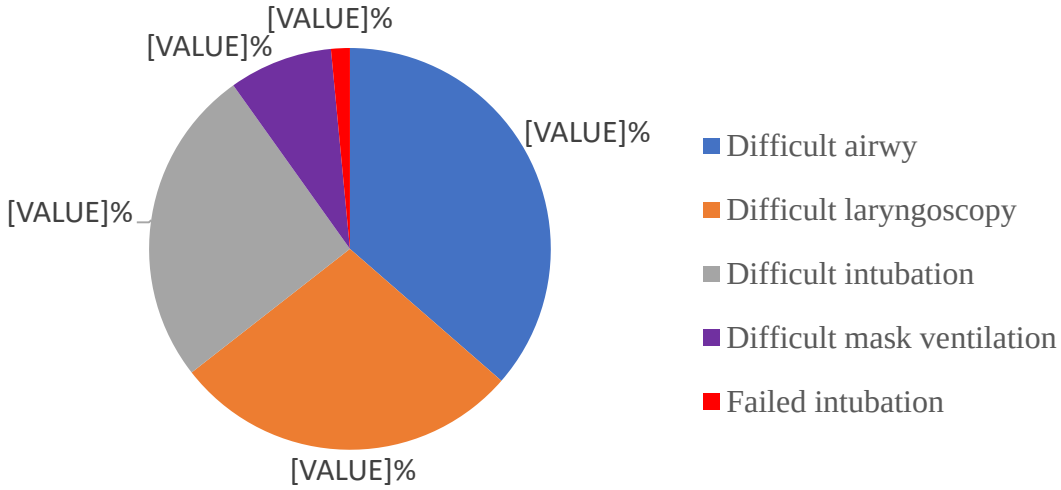

Figure 2: Magnitude of difficult airway in adult participants who underwent elective maxillofacial with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021.

Majority of patients who underwent elective maxillofacial surgery with endotracheal intubation were grade one in terms of Han mask ventilation grading scale and Cormack and Lehan's laryngoscopy view (**figure 3**).

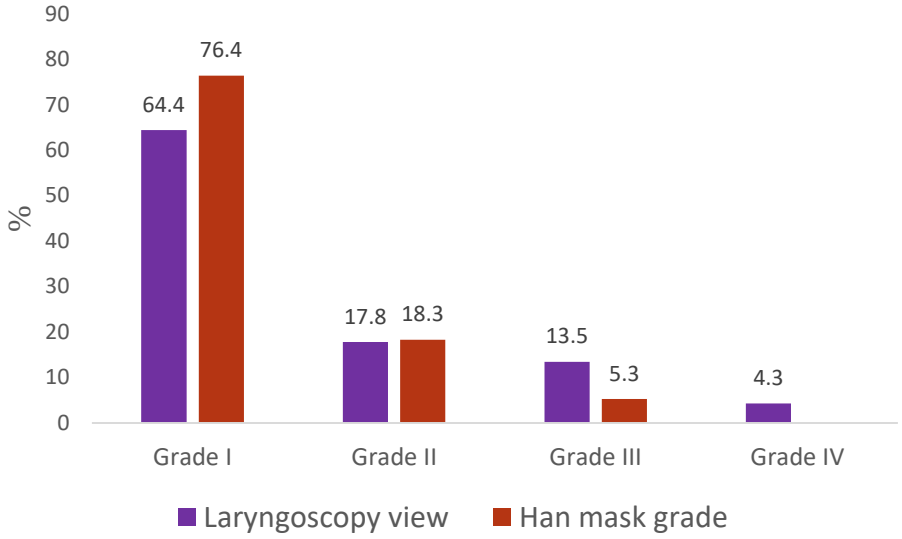

Figure 3: Han mask ventilation grading scale and Cormack - Lehan's laryngoscopy view grade distribution for adult study participants who underwent elective maxillofacial operation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021.

Among study participants who underwent elective operation, more than half of them had easy intubation (**Figure4**)

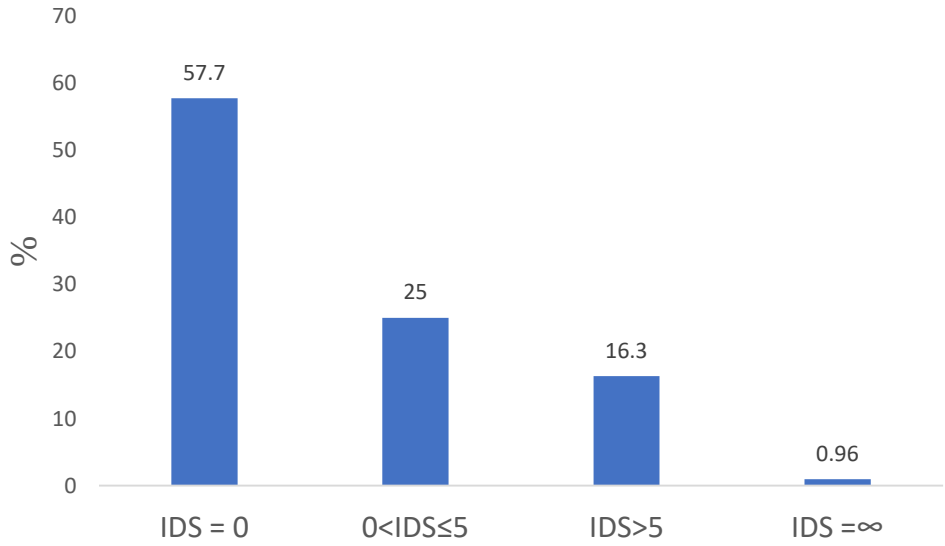

Figure 4: Distribution of Intubation Difficult Score for adult study participants who underwent elective maxillofacial operation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021.

Table 2: Preoperative patient factors and their distribution for a study participant who underwent maxillofacial operation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021.

Variables	Category	Frequency (n), Percentage (%)
OPV	I	117 (56.25)
	II	42 (20.2)
	III	27 (13)
	IV	22 (10.6)
TMD	>6cm	183 (88)
	<6cm	25 (12)
SMD	>12cm	180 (86.5)
	<12cm	28 (13.5)
IIG	>4cm	163 (78.4)
	<4cm	45 (21.6)
Jaw slide	A	147 (70.6)
	B	32 (15.4)
	C	29 (14)
ULBT	I	142 (68.3)
	II	42 (20.2)
	III	24 (11.5)
History of snoring	Yes	41 (19.7)
	No	167 (80.3)
History of diabetes mellites	Yes	6 (2.9)
	No	202 (97.1)
History of head and neck surgery	Yes	8 (3.8)
	No	200 (96.2)
Routes of intubation	Nasal	81 (38.95)
	Oral	127 (61.05)

5.2 Association of factors with difficult airway

Table3, shows the relationship between independent factors and difficult airway. Inter incisor gap, jaw slide, previous head and neck surgery, history of diabetes mellites and routes of tracheal insertion were not significantly associated with difficult airway at p values less than 0.05**.** Inability to use both alternative techniques and laryngeal pressure increase the incidence of difficult airway (**Figure 5**).

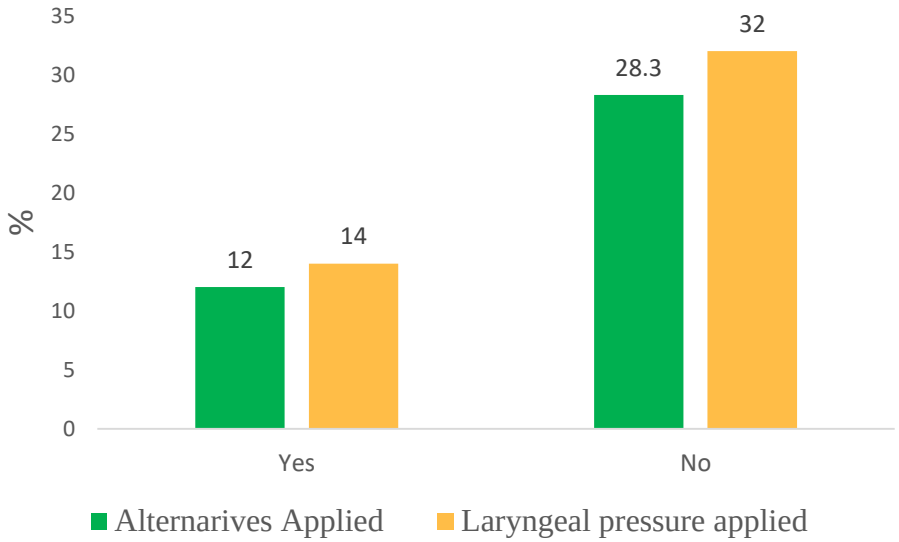

Figure 5: Relationship between difficult airway and application of both alternative techniques and laryngeal pressure for adult study participants who underwent elective maxillofacial operation at selected hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/2021

Table 3: Factors associated with difficulty airway for participants who underwent elective maxillofacial surgery with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia from January 22/2021 to May 21/ 2021.

Factors	Category	P – value	AOR.	95% C.I.	
				Lower limit	Upper limit
Sex	Female	***	***	***	***
	Male	0.163	1.609	0.825	3.138
Age (years)	18-35	***	***	***	***
	36-55	0.164	2.166	0.736	6.081
	Above 55	0.010	4.844	1.463	16.034
BMI (kg/m^2)	18.5-24.9	***	***	***	***
	Below 18.5	0.856	0.856	0.157	4.684
	25-29.9	0.577	1.445	0.397	5.264
	Above 30	0.024	2.592	1.131	5.937
OPV class	I	***	***	***	***
	II	0.093	2.087	0.884	4.927
	III	0.098	3.460	1.358	8.815
	IV	0.002	4.902	1.832	13.116
	<6cm	0.010	4.581	1.925	10.899
TMD	>6cm	***	***	***	***
SMD	<12cm	0.000	6.167	2.661	14.289
	>12cm	***	***	***	***
IIG	>4cm	***	***	***	***
	<4cm	0.750	2.104	0.022	205.375
JS grade	A	***	***	***	***
	B	0.393	0.385	0.430	3.431
	C	0.089	0.055	0.002	1.557
ULBT class	I	***	***	***	***
	II	0.059	2.182	0.971	4.910
	III	0.000	7.636	3.013	19.357

Factors	Category	P value	AOR	95% C.I.	
				Lower limit	Upper limit
Alternative techniques	Applied	***	***	***	***
	Not Applied	0.032	2.477	1.087	5.665
Laryngeal pressure	Applied	***	***	***	***
	Not Applied	0.04	2.811	1.388	5.691
History of head and neck surgery	Yes	0.111	2.477	0.811	7.558
	No	***	***	***	***
Snoring history	Yes	0.010	3.574	1.718	7.435
	No	***	***	***	***
Diabetic history	Yes	0.185	0.170	0.012	2.339
	No	***	***	***	***
Routes of intubation	Oral	***	***	***	***
	Nasal	0.358	1.543	0.612	3.892

*** = Reference group

CHAPTER SIX: DISCUSSION

General anesthesia is accompanied with lots of life-threatening events. Of these, the commonest one that can happen during induction of general anesthesia with endotracheal tube insertion under laryngoscopy is difficult airway (32).

Our study assesses both magnitude and associated risk factors of difficult airway among elective adult maxillofacial surgical patients who underwent general anesthesia with endotracheal intubation. We found that the magnitude of difficult airway was 23.1%. This finding was in line with studies conducted on maxillofacial surgical patients in different countries of the world (8,12,20).

There was a wide variation in the reported magnitude of difficult airway in available literatures, ranged from 11.76% to 32% (7). Our result is higher than a prospective cross sectional study conducted by Dong et al (16) on 116 elective maxillofacial surgical patients aged from 16 to 78 years where the magnitude was 15.4%. This variation may be due to different terms that were used to define difficult airway (28). We defined difficult intubation in terms of Intubation Difficult Score, whereas Dong et al defined it as attempts which are more than three.

Our study also investigated the incidence of difficult laryngoscopy, difficult intubation, difficult mask ventilation and failed intubation where the magnitudes were 17.8%, 16.3%, 5.3% and 0.96% respectively.

Orfanos and Quereshy (9) stated that, depending on the terms used to define, magnitude of difficult mask ventilation in maxillofacial procedures varied widely from 0.9% to 15%. Our finding was in line with as study conducted by Tulay et al (27) predicted incidence of difficult mask ventilation as 7.8% (27). Our result was however, lower than a retrospective study conducted by Cattano et al (19) in Texas medical center where the magnitude was 8.9%. The possible reason for this variation could be due to different study design. Our study design was prospective cross sectional while their study was retrospective cross sectional study design.

It is also higher than a study reported by Wong et al (17) whose finding was 0.8%. This significance variation may be due to the use of different terms to define difficult mask ventilation. We defined difficult mask ventilation as Han mask grading scale three whereas

Wong et al defined it as pulse oximetry recording of oxygen saturation below 92% after induction of anesthesia.

In our study, magnitude of difficult laryngoscopy was 17.8%, which is comparable to a study investigated by Matsuura and Hiroso (12) stated that the incidence of difficult laryngoscopy was 16.9%.

Piriyapatsom et al (8) conducted a prospective multicentered cross sectional study on 1996 patients aged from 17 years and above underwent maxillofacial surgery. They found that the incidence of difficult intubation was15.38%. This result is comparable to our finding.
Our finding, however, was not in line with a study conducted by Tuzuner et al (22). They identified magnitude of difficult intubation and failed intubation as 11.82% and 0.035% respectively. The possible reasons for this variation could be again due to different terms used to define difficult intubation. We define difficult intubation in terms of Intubation Difficult Score, but they defined it as more than three laryngoscopy attempts. Regrading failed intubation, it could be due to differences in access to difficult airway management supplies.

In our study, multivariable logistic regression showed that age, body mass index above 30kg/m^2, oropharyngeal view IV, thyromental distance below 6cm, sternomental distance below 12cm, upper lip bite test class III and history of snoring were statistically significant predicting factors for difficult airway.

Patients who had body mass index above 30kg/m^2 and age above 55 years had almost three and four times more likely to have difficult airway than those having 18.5-24.9 kg/m^2 and ages 18-35 years respectively. These findings are consistent with a study conducted by Evans and Mccahon (11), but contradicted with a study reported by Tafesse and Ataro (30). They found that both age and body mass index were not significantly associated with difficult airway. The possible reason for patients with increased body mass index to have difficult airway could be due to distribution of body fat in the pharyngeal tissues which result in airway collapsibility (27). Regarding age, it is due to stiffness of atlantooccipital and temporomandibular joints (18).

Patients with oropharyngeal view class IV were almost five times riskier to have difficult airway compared to class I (**table3**) which was a similar result with a study conducted by Gupta et al

(14). They justified that modified mallampati class IV had significant association with difficult airway.

Our finding, however was contradicted to a study conducted by Abdulla et al (15). The possible reason for this difference could be due to skill variation in grading Mallampati classes.

Patients with thyromental distance below 6cm, sternomental distance below 12 cm and upper lip bite test class III were five, six and seven times that of thyromental distance >6, sternomental distance >12 and upper lip bite test class I respectively(**table3**). This finding is similar with a study conducted by Dong et al (16). Similar to a study conducted by Evans and Mccahon (11), our study showed that patients who had history of snoring were more likely to have difficult mask ventilation.

In line with a study conducted by Workeneh et al (25), our study identified that inability to use alternative techniques and laryngeal manipulation showed significant association with difficult intubation and laryngoscopy.

In contrast to Gupta et al (14) , our study stated that inter incisor distance and jaw slide grading scale didn't show significance association with difficult airway. These differences could be more likely due to the use of different cut off values and different clinical skills respectively. To determine the significance of inter incisor gap, they used a cutoff point <4cm, but we used a cutoff point <4.5cm. The reason why we preferred higher cutoff point is because in normal instances, inter incisor gap can admit three fingers which is about 4.5cm. Regarding jaw slide, it might be due to different clinical skills of anesthesia provider.

Horishita et al (23) conducted a comparative cross sectional study, described that previous history of head and neck surgery was statistically significant with difficult airway, whereas our finding did not show significant association. The most likely difference could be different study designs.

In contrast to a comparative cross sectional study which was conducted by Warner *et al* (29) on 725 patients, our result showed diabetes mellites did not significantly associate with difficult airway. The possible reason for this significant variation could be again due to differences in study designs.

According to our study, gender was not statistically significant with difficult airway. Our finding was supported by a study conducted at Black Lion Specialized Hospital to predict values of preoperative tests for difficult laryngoscopy and intubation in adult patients (31).

Wong et al (24) however, found that male sex was an independent risk factor for difficult airway. The possible reason for this significance variation could be sample size differences. They studied on 644 patients but we studied on 208 patients due to time and financial constraints.

CHAPTER SEVEN: LIMITATION AND STRENGTH OF THE STUDY

7.1 Limitation of the study

Numbers of participants involved in this study during study period were not adequate for the desired study design due to time and financial constraints.

7.2 Strength of the study

Since the study participants were nearly equal with source of population, the result can generalize for the whole population.

Additionally, there were no researches done regarding this topic in the study area and the remaining part of the country, hence, it can help as a baseline data for researchers to investigate further on it.

CHAPTER EIGHT: CONCLUSION AND RECOMMENDATION

8.1 Conclusion

The findings of our study demonstrates that magnitude of difficult airway, difficult laryngoscopy, difficult intubation difficult, difficult mask ventilation and failed intubation was 23.1%, 17.8, 16.3%, 5.3% and 0.96% respectively. The main independent predictors of such problems were upper lip bite test class III, oropharyngeal view grade IV, sternomental distance <12cm, thyromental distance <6 cm, body mass index above 30kg/m^2, age above 55 years and history of snoring.

8.2 Recommendation

Anesthesia providers and hospital administrators should give attention to minimize the incidence of difficult airway. Health facilities are recommended to make sure that the presence of fully equipped facilities to manage difficult airway when difficulties encountered. Appropriate use of alternative techniques and laryngeal manipulation are highly recommended to anesthetists so as to the decrease incidence. We also recommend researchers to conduct a multi-center study in this particular topic in a large scale.

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Annexes

Annex I: Consent form

Amharic version verbal consent form before conducting interview

ከቃለ ማኪይቅ በፊት ፈቃደኝነት ማስየቂያ ቅጽ:

ጤፍ ይስጥልኝ! እኔ _____እባላለሁ። እዚህ የተገኘሁት በአዲስ አበባ ዩንቨርስቲ አንስትዚያ ትምህርት ክፍል የጥናት ቡድን አባል ለሆነው ለገሠ ደምሴ ሚጃ ለማብሰብ ነው። የጥናቱ ዋና አላማ ካንገት በላይ አፕራሲአን ለሚደረግላችው ታካሚዎች ሰው ሰራሽ የመተንፈሻ ሚጃ ማሪያዎችን በአፕራሲዮን ጊዜ የማስገባት ችግር ምን ያህል እንደሆነ እና ተያያዝ ችግሮችን በሚጃ በተደገፈ ሜልኩ ለማጥናት ነው። ትክክለኛ የሰውሰራሽ የመተንፈሻ ሚጃ ማሪያ አጠቃቀም አፕራሲአን ለሚደረጉ ህመማን ህይወትን ሊነጥቅ ከሚችል ችግር ይታደጋል። በዚህ ጥናት ማሳተፎም ሆነ አለማሳተፎ በሆስፒታሉ ውስጥ በሚያገኙት አገልግሎት ላይ ምንም አይነት ለውጥ አያመጣም። የተሚጠቅም በዚህ ሆስፒታል ቀዶ ጥገና ስለተደረገልወት ብቻ ነው። ቃለማኪይቁን በማናቸውም ሰአት ማቋረጥ ወይም ጥያቄዎችን አለመመለስ ይችላሉ። ለጥያቄዎች የሚሰጡዉ ሜልሶች በሚስጥር የሚከበቁ ሲሆን የእርሶ ስም ወይንም እርሶን የሚለይ ማንኛውም ሚጃ አይገለጽም። እንዲሁም የሚሰጡት ምላሽ ከርሶ ማንነት ጋር በማንኛውም ሜልኩ አይያያዝም። ቅፁን ለመሞላት የሚወስደው ጊዜ ከ15 ደቂቃ አይበልጥም።

በጥናቱ ለማሳተፍ ፈቃደኛነዎት? 1. አዎ 2. ፍቃደኛ አደለሁም

በጥናቱ ለማሳተፍ ፈቃደኛ ከሆኑ ቃለማኪይቁን ማቀጠል ይቻላል።።

የማኪይቁ ማላያ ቁጥር ---------- ማኪይቁ የተካሄደበት ቀን ---------- የተጀሚበት ሰአት ------

የጠያቂውሥምና ፊርማ----------

የሱፐርቫይዘር ስምና ፈርማ----------

ስለ ትብብሮምአ ማስ ግና ለ ሁ!
ጥና ቱን በ ተ ማ ላ ከ ተ ማ ን ኛ ዉ ም አ ይ ነ ት ጥ ያ ቄ ካ ላ ች ሁ የ ሚ ከ ተ ለ ዉ ን አ ድ ራ ሻ ይ ጠ ቀ ሙ

በ ዋ ና ነ ት ም ር ም ሩ ን የ ሚ ያ ካ ሂ ዉ ሰ ዉ ስ ም ገ ሠ ሠ ደ ምሴ ታ ፈ ረ

ስ ል ክ : +251918819456

ኢ ሜ ል : gesdemtaf2@gmail.com

English version verbal consent form

Greeting, my name is _____. I'm a data collector on the behalf of Gessesse Demessie for the study entitled "The magnitude of difficult airway and associated factors in adult patients who underwent elective maxillofacial operations with endotracheal intubation at selected hospitals, Addis Ababa, Ethiopia". The purpose of this study is to gather information on magnitude and associate factors of difficult airway in adult patients who underwent elective maxillofacial operations with endotracheal intubation at selected hospitals, Addis Ababa, Ethiopia. Being a part of this study will not affect in any way the service you are getting in this hospital. You are selected randomly to participate in the study just because you will undergo surgery in this hospital and no other special criteria. You are free to withdraw from the study and you can stop answering to any questions that are forwarded to you at any time you want. In the study any answer you gave, your name and address or any information that identifies you will be confidential.

This form will take a maximum of 15 minutes to be filled. Therefore, you are kindly requested to participate on this study based on your willingness.

A. Agree B. Disagree

If you agree, the interview will be started.

Questionnaire Code _____ Starting time_____

Thank you for your participation!

For more information and question contact the investigator: Gessesse Demessie Tafere

Tel: +251918819456

Email: **gesdemtaf2@gmail.com**

Annex II: check list

Name of the institute: _____ **Email address:** _____ **Instruction:** For each of the questions, please circle the number of alternative(s) that fit the response, fill the blank space provided or provide appropriate response accordingly.		
Part one: Socio demographic characteristics		
S. No	**Parameters**	**Response**
101	Age	……years
102	Sex	A. Male B. Female
103	Weight	……. Kg
104	Height	……. Cm
105	BMI	…… Kg/m^2
Part Two: Preoperative patient related factors		
201	ASA status	A. I B. II C. III D. IV
202	Oropharyngeal view /OPV	A. I B. II C. III D. IV
203	Jaw slide/JS	A. A B. B C. C
204	Upper lip bite test class/ULBT	A. I B. II C. III
205	Interincisal gap/IIG	A. < 4cm B. ≥ 4cm

206	Thyromental distance/TMD	A. < 6cm B. ≥ 6cm
207	Sternomental distance/SMD	A. < 12cm B. ≥ 12 cm
208	Does the patient have history of head and neck region surgery?	A. Yes B. No
209	Does the patient have history of snoring?	A. Yes B. No
210	Does the patient have history of diabetes mellites/DM?	A. Yes B. No
Part III: Mask ventilation related factors		
Note: Han Mask Ventilation grading system **Grade I: Ventilated by mask; Grade II: Ventilated by mask with oral airway or another adjuvant.** **Grade III: DMV (inadequate, unstable, or requiring two practitioners); Grade IV: Unable to mask ventilate.**		
301	Han Mask Ventilation Grade	A. I B. II C. III D. IV
Part IV: Laryngoscopy **Note: Laryngoscopy view grading scale. Grade I = full view of glottis (opening), Grade II = partial view of glottis, Grade III = only epiglottis is visible, Grade IV= Neither glottis nor epiglottis is visible.**		
401	Cormack and Lehane laryngoscopy grade	A. I B. II C. III D. IV
402	Number of laryngoscopy attempts	A. I B. II C. III D. > III
Part V: Endotracheal intubation		
501	Routes of intubation	A. Oral B. Nasal
502	Were alternatives used to facilitate intubation?	A. Yes B. No
	If yes, you can encircle more than one alternative given below whenever applied.	A. Reposition of the patient B. Different tube sizes used

		C. Changing from oral to blind nasal intubation D. Stylet F. Budgie G. Glide scope H. Fiberscope I. None used
503	Number of intubation attempts	A. 1 B. 2 C. 3 D. > 3 (Specify…….)
504	Number of operators required to directly perform intubation	A. 1 B. 2 C. 3 D. > 3 (Specify……)
505	Position of vocal cords while intubation	A. Closed B. Opened
506	Lifting force required during laryngoscopy	A. Normal B. Increased
507	Is external laryngeal pressure applied?	A. Yes B. No
508	Total intubation difficult score /IDS	A. 0 B. 1-5 C. > 5 D. ∞
	Parametres for IDS: **N1**: Number of attempts required : if more than one, give 1 piont for each **N2**: Number of operators required : if more than one, give 1 point for each **N3**: Number of alternative techniques used (requirment of stylet, boudge, changing intubation from oral to blind nasal, use of different size ETT or laryngoscope baldes, etc. give 1 point for each). **N4**: Cormack laryngoscopy grades: if greator than one, give 1 piont. **N5**: Lifting force required: if increased, give 1 point. **N6**: Laryngeal pressure applied: if applied give 1 point **N7**: Position of vocla cord: if adducted or closed, give 1 point, if not possible to visualize vocal cords, by default give zero point.	
509	Time taken to intubate the patient	A. ≤ 10 minutes B. > 10 minutes

510	Is the patient awakened and surgery postponed?	A. Yes	B. No
511	Is there complication during intubation?	A. Yes	B. No

Data collector:

Name: _____ Signature _____ Date _____

Supervisor:

Name: _____ Signature _____ Date _____

Annex III: Information sheet

Title of the Research Project

Magnitude and Associated Factors of Difficult Airway in Adult Patients Who Underwent Elective Maxillofacial Operation with Endotracheal Intubation at Selected Public Hospitals, Addis Ababa, Ethiopia, 2021: A cross-sectional study**.**

Name of principal investigator: **Gessesse Demessie Tafere**

Name of advisors: **Ashenafi Seifu**

Tinbite Daniel

Name of institution: **Addis Ababa University**

College of Health Sciences

School of Anesthesia

Name of sponsor: **Addis Ababa University**

Introduction

This information sheet is prepared with the aim of assessing magnitude and Associated Factors of Difficult Airway in Adult Patients Who Underwent Elective Maxillofacial Operation with Endotracheal Intubation at Selected Public Hospitals, Addis Ababa, Ethiopia, 2021. The research group includes the principal investigator, three data collectors, one supervisor and two advisors from Addis Ababa University.

Purpose of the Research Project

The aim of this study is to assess magnitude and associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021. Assessing magnitude of difficult airway and its associated risk factors is important for participants, health service providers and other stakeholders to give emphasis on the incidence. The results of this study will be used to design appropriate intervention programs and minimize the extent of the problem in the study areas and other health institutions in Ethiopia.

Procedure

This study will involve adult participants who come for elective maxillofacial operation with endotracheal intubation at selected public hospitals, Addis Ababa, Ethiopia, 2021. They will be selected to be one of the study participants if they are willing to participate in this study and ready to give oral consent.

Benefits, Risk or Discomfort

We inform that by participating in this research project, they may feel some discomfort in wasting their time (a maximum of 15 minute). Nonetheless, their participation is definitely important to determine magnitude and associated factors of difficult airway in adult patients who underwent elective maxillofacial operation with endotracheal intubation and take immediate intervention to minimize its incidence in maxillofacial patients. There is no risk to the study participants in participating in this research project.

Confidentiality

The information collected from study participants will be kept confidential and stored in a file. Name of study participants is given a code number; hence no report of the study will ever identify the participants.

Right to Refusal or Withdraw

They will have full right to refuse from participating in this research. They have also the full right to withdraw from this study at any time they want.

Whom to contact

For any questions or concerns you can contact the principal investigator using the following addresses.

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