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Predictive values of Anatomical Parameters for difficult Mask ventilation.

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Abstract

Difficulties in mask ventilation have been associated with serious complications that may result in death. Predictions may reduce the risks considerably. Our study aims were to assess the incidence and predictive values of anatomical parameters for difficult mask ventilation among patients who underwent elective surgeries. Cross sectional study was conducted on 278 patients. Patient demographics, incidence and predictive values of anatomical parameters for difficult mask ventilation were studied. Our findings showed the incidence of difficult mask ventilation (grade III) as 2.2 % and impossible mask ventilation (grade IV) as 0.4%. Highest percent of difficult mask ventilation (grade III) was occurred in patients with obstructive sleep apnea, BMI $> 26 \text{kg/m}^2$, Mandibular Protrusion Class B and C, Neck circumference $> 40 \text{cm}$, history of snoring, and Modified Mallampatti Class III. All together, we conclude that Modified Mallampatti class III and Mandibular protrusion class B & C are highly accurate parameters with high specificity, negative predictive value and positive predictive value for difficult mask ventilation (grade III) compared with other parameters.

Keywords: anatomical, anesthesia, difficult mask ventilation, impossible mask ventilation, patients, wolaita sodo, Ethiopia.

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DECLARATION

This is to certify that the thesis prepared by **Kifle H/Gebriel**, entitled: Predictive values of anatomical parameters for difficult mask ventilation among patients who underwent elective surgeries at Wolaita sodo University teaching and referral hospital and sodo Christian hospital in Ethiopia from July 1- August 30, 2017 and submitted in partial fulfillment of the requirements for the Degree of Masters of Science in Medical Anatomy complies with the regulations of the university and meets the accepted standards with respect to originality and quality. This thesis has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged. The Thesis has passed with **EXCELLENT** remark.

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Abbreviations and Acronyms

ASA American Society of Anesthesiologists

DA Difficult Airway

DI Difficult Intubation

DMV Difficult mask ventilation

GA General Anesthesia

IID Inter Incisor Distance

IMV Impossible mask ventilation

MMC Modified Mallampatti Class

MP Mandibular Protrusion

NC Neck circumference

NM Neck mobility

OSA Obstructive sleep apnea

ROC Receiver Operating Characteristics

SCH Sodo Christian Hospital

SMD Sternomental Distance

TMD Thyromental Distance

WSUTRH Wolaita sodo University teaching and referral Hospital

1. INTRODUCTION

1.1. Background

Mask ventilation is an integral skill for all anesthetists. It forms the starting point of the majority of general anesthetics and more importantly, it is an essential fall-back technique for maintaining oxygenation during a failed or difficult intubation. Despite its importance, less attention is devoted to mask ventilation in research papers, with a larger focus on difficult or failed intubation(**Stephen P. et al., 2010**).

The use of a face mask can facilitate delivery of oxygen or of an anesthetic gas from a breathing system to a patient by creating an airtight seal with the patient's face. The rim of the mask is contoured and conforms to a variety of facial features. Several mask designs are available. Transparent masks allow observation of exhaled humidified gas and immediate recognition of vomiting. Black rubber masks are pliable enough to adapt to uncommon facial structures. Retaining hooks surrounding the orifice can be attached to a head strap so that the mask does not have to be continually held in place(**G. Edward Morgan et al., 2005**).

Effective ventilation requires both a gas-tight mask fit and a patent airway. Improper face mask technique can result in continued deflation of the anesthesia reservoir bag when the adjustable pressure-limiting valve is closed, usually indicating a substantial leak around the mask. In contrast, the generation of high breathing-circuit pressures with minimal chest movement and breath sounds implies an obstructed airway. Both these problems are usually resolved by proper technique. If the mask is held with the left hand, the right hand can be used to generate positive-pressure ventilation by squeezing the breathing bag. The mask is held against the face by downward pressure on the mask body exerted by the left thumb and index finger. The middle and ring finger grasp the mandible to facilitate extension of the atlantooccipital joint. Finger pressure should be placed on the bony mandible and not on the soft tissues supporting the base of the tongue, which may obstruct the airway. The little finger is placed under the angle of the jaw and used to thrust the jaw anteriorly, the most important maneuver to allow ventilation to the patient(**G. Edward Morgan et al., 2005**).

The American society of anesthesiologists defined difficult mask ventilation as a situation in which: “It is not possible for the anesthesiologist to provide adequate ventilation because of one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas.”The American society of anesthesiologists then goes on to list signs of inadequate ventilation: absent or inadequate chest movement, absent or inadequate breath sounds, auscultatory signs of severe obstruction, cyanosis, gastric air entry or dilatation, decreasing or inadequate oxygen saturation, absent or inadequate exhaled carbon dioxide, absent or inadequate spirometric measures of exhaled gas flow, and hemodynamic changes(**ASA et al., 2013**).

Difficult mask ventilation(DMV) is subjectively defined when signs of inadequate ventilation like gas leak around the mask, no perceptible chest movements, oxygen saturation less than 92% by pulse oxymetry are seen and alternative methods to facilitate mask ventilation is required e.g. two-handed mask ventilation, insertion of oropharyngeal or nasopharyngeal airway and change of operator during general anesthesia(**Langeron O et al., 2000**).

Evaluation anatomy of patient used by anesthetists, currently based on history and physical findings, is used to detect potential difficulties with tracheal intubation.The ability to predict Difficult mask ventilation is equally or, arguably, even more important to patient safety(**Benumof, 1991**).

There is a wide variation in the reported incidence of DMV in the literature. Whereas one study reported an incidence as low as 0.08%, another reported a 15% incidence. The highest incidence (15%) was reported from a retrospective study of subjects who had difficult intubation. The majority of prospective studies, on the other hand, reported a lower incidence. 0.9%(**Rose and Cohen., 1994**), 5%(**Langeron O et al., 2000**) and 7.8%(**Yildiz T et al., 2005**). The large prospective study of 22,660 MV attempts used a DMV grading scale and reported an incidence of 1.4%. Because this is the large and most recent study and because the reported incidence is in agreement with several other studies 1.4% may be considered the most likely estimate in the general population(**Kheterpal S et al., 2006**).

1.2. Statement of the problem

Mask ventilation (MV), as a main essential technique in controlling airway, provides oxygenation and ventilation before securing a stable airway. Thanks to its life-saving properties, MV is of special importance to the rescuers(**Soleimanpour H et al., 2012**).

Moreover, the airway risk assessment tools in widespread use were mostly focused on one specific aspect of a difficult airway (i.e. difficult laryngoscopy, difficult intubation). In More recent years, this paradigm has shifted to a more functional approach with greater emphasis placed on the overall importance of the airway patency. Indeed, due to early data demonstrating the significant risk of respiratory depression associated with sedation, The Joint Commission and Centers for Medicare and Medicaid Services has implemented policies to ensure evaluation of the risk for a difficult airway prior to procedures. Moreover, the 2013 ASA Practice Guidelines for Management of the Difficult Airway caution about the risks of a DMV due to upper airway obstruction and recommend an airway risk assessment before every anesthesia procedure is performed(**Apfelbaum J et al., 2013**).

Airway management of anesthetized patients is one of the most important responsibilities of anesthesiologist. Using mask ventilation is the primary means of maintaining airway and providing adequate ventilation and oxygenation before attempting tracheal intubation. Ability to provide adequate ventilation via a face mask will be the most important factor in preventing hypoxia development and subsequent neurological damage. Mask ventilation forms the basis of airway management. Providing mask ventilation before endotracheal intubation or other methods (e.g. tracheostomy or cricothyrotomy) is a basic but potentially life-saving airway technique that allows oxygenation and ventilation in patients without a reliable airway(**Rose and Cohen., 1994**). Difficulty or failure in managing the airway of patients is an important factor in increased morbidity and mortality linked to anesthesia(**Rudra., 2005**)

Respiratory events are the most common anesthetic related injuries. One of the three main causes of respiratory related injuries is inadequate ventilation and the rest are esophageal intubation and difficult tracheal intubation. In fact up to 28% of all anesthesia related deaths are secondary to the inability to mask ventilate or intubate(**Sunanda G et al., 2005**).Unanticipated DMV places

patients at increased risk of complications. These complications are probably the result of a lack of accurate predictive anatomic measurements(**Smita P et al., 2013**).

1.3. Significance of the study

For more than three decades, poor airway management was recognized as a serious patient safety concern, emphasizing the need for a careful airway assessment and identifying the predictors for a difficult airway(**Peterson et al., 2005**).

Factors associated with anatomy of patient are the most common cause of DMV. The diagnostic accuracy of anatomical parameters varies between different studies. This is attributed to difference in the incidence of DMV among different population. Differences in the patient anatomy, clinical setup and skill of the anesthetists can also influence the incidence of DMV. In addition to this, as to my knowledge, there is no published data on the predictive values of anatomical parameters for DMV in our country.

Evidence based local or national data on the Predictive values of anatomical parameters will help anesthetists to improve quality of anesthesia care. The purpose of this study was therefore, to provide evidence based information to the anesthetists and other concerned professionals to describe the predictive values of clinically useful anatomical parameters for DMV. This study can contribute in the improvement of anesthesia quality care by decreasing morbidity and mortality of patients associated with DMV. 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 DMV.

The result can help anesthetists to better consider the problem now more than any other time before to consider patients with risk factors, assess their patients preoperatively for any possible DMV, prepare equipments and adhere to systematic algorithms in cases of difficulty, thereby decreasing patient morbidity and mortality.

2. LITERATURE REVIEW

2.1. Factors affecting mask ventilation

2.1.1. Anatomical factors

Factors associated with anatomy are the main cause for DMV. A neck circumference (>40cm), which is associated with obesity, increases the probability of DMV. Increasing age is another risk factor and this is likely due to the loss of elasticity in tissues and presence of lung disease. The Mandibular protrusion test gives the assessor an indication of the ability to perform an adequate jaw thrust, and is important in patients at risk of upper airway collapse. Furthermore, it is also a good predictor of difficult intubation.

In a prospective study of 1502 patients, **(Langeron O et al., 2000)** performed a multivariate analysis of preoperative findings that were correlated with DMV and found five anatomical risk factors to be significantly associated with DMV and thus may be used as predictors. These were: age older than 55 yr, body mass index (BMI) more than 26 kg/m², lack of teeth, history of snoring, and presence of a beard. The presence of at least two of these factors indicated a high likelihood of DMV. Similarly, an analysis by **(Yildiz T et al., 2005)** found age, weight, history of snoring, male gender, and Mallampatti Class IV to be significantly associated with DMV.

With respect to impossible mask ventilation, **(Kheterpal S et al., 2009)** reviewed over 50,000 anesthetics with an incidence of 0.15% and showed the following independent predictors: neck radiation, male sex, sleep apnea, Mallampatti 3&4, and the presence of a beard.

Other anatomical factors include large tongue in relation to the pharyngeal space, tonsillar hyperplasia, redundant tissues leading to pharyngeal wall collapse in morbidly obese and sleep apnea patients, and pharyngeal and neck tumors **(Sofferman RA, 1997)**.

Upper airway trauma, including iatrogenic trauma induced by repeated attempts at tracheal intubation, can lead to edema and swelling of the tongue and pharyngeal and laryngeal structures **(Davies JM, 1989)**.

Facial and maxillary tumors may lead to an impossible mask fit or encroach on the upper airway **(Gabbott DA, 1997)**.

Thyroid tumors, laryngeal polyps, and laryngeal carcinoma can all lead to DMV and in some cases IMV(**White and MacRae, 1999**).

Mediastinal or tracheal masses, foreign body aspiration, severe bronchospasm, stiff lungs, pneumothorax, bronchopleural fistula, and bronchial tumors have all been reported as causes of DMV or IMV(**Kron, 2001**).

Severe Kyphoscoliosis and chest wall deformity can also impede expansion and decrease compliance(**Conti G et al., 1997**).

It is important to go through the list of differential diagnoses when managing a DMV situation to rectify the correctable causes and consider alternative interventions if initial measures fail(**Keon, 1985**).

2.1.2. Operator-Related Factors

The skill of using the face mask for ventilation is acquired through formal training and retained by regular practice afterward. More than 50% of emergency medical technicians were not able to ventilate a mannequin(**Elling R and J, 1983**).

In another study, 84% of emergency room nurses were not able to adequately perform MV(**De Regge M et al., 2006**).

Simple techniques to achieve a tight seal in patients with abnormal anatomy are learned by experience. Others, such as keeping the dentures in edentulous patients or placing an oral Airway in patients with small chins (**Conlon NP et al., 2007**).

2.1.3. Equipment-Related Factors

Basic equipment needed for MV comprises the face mask and the respiratory bag. Other adjunct airway devices like the oropharyngeal and nasopharyngeal airways are sometimes needed for airway patency(**Redfern D et al., 2006**).

The design of the mask can affect the effectiveness of ventilation. Transparent disposable masks with cushion rims are the ones most commonly used in anesthesia. Regardless of the mask type or design, it is crucial to obtain a tight seal with the face(**Greenberg, 2002**).

Leaks may develop due to the inability to obtain a tight seal. This may result from an improperly inflated cushion, improper mask size, presence of a beard, or abnormal facial anatomy. A tight

seal is more easily obtained when using masks with high-volume, low-pressure cushions(**Lee LA and Domino, 2002**).

Different types and sizes of airways are available, and it is important to choose the correct size. A short airway may not relieve distal soft tissue obstruction and may in fact cause obstruction by pressing on the tongue. An extra long airway may elicit reflex responses like coughing, retching, vomiting, laryngeal spasm, or bronchial spasm especially when inserted at light planes of anesthesia(**El-Ganzouri AR et al., 1996**).

Suboptimal head and neck positioning may lead to DMV. The sniffing position increases the pharyngeal space, which may render MV more efficient(**Isono S et al., 2005**).

2.1.4. Drug-Related Causes

High doses of opioids may decrease ventilator compliance and result in DMV. The main reason for the difficulty was originally thought to be chest wall rigidity(**Comstock M et al., 1981**).

Light anesthesia may be associated with increased chest wall muscle tone, breath holding, and coughing. This may lead to decreased chest wall expansion and reduced compliance resulting in DMV(**Fletcher ME et al., 1991**).

2.2. Complications of difficult mask ventilation

The most serious complication of DMV is failure to establish ventilation, resulting in death or hypoxic brain damage. Other less serious complications may occur if the operator is not attentive to the anatomical structures under the mask. This is especially evident when MV is difficult because most of the attention is focused on establishing adequate ventilation(**Lee LA and Domino, 2002**).

The eyes and eyelids are vulnerable to injury from a foreign body, pressure, dry gases, or the Anesthetist's hands. Pressure necrosis and trauma to the Nose Bridge and chin have been reported(**Roth S et al., 1996**).

Lip and nerve injuries may also occur(**Azar I, 1986**).

Failure to anticipate difficult mask ventilation before anesthesia induction in 57% of the patients who were ultimately difficult to ventilate(**Asai T et al., 1998**).

There is a relationship between DMV and the incidence of Difficult Intubation (DI). Patients with DMV to have a higher incidence of DI than those with easy MV. The authors found the incidence of DI to be 8% in patients who had no DMV, and 30% in those who had DMV, a fourfold increase. They also found a 12-fold increase in the incidence of impossible intubation (0.5% versus 6%) in patients who had DMV. Although the true incidence of DI is 8%, the important message is that patients with DMV have a higher incidence of DI. Many factors that predispose to DMV also predispose to DI (Khetarpal S et al., 2006).

3. OBJECTIVES

3.1. General Objective

To assess predictive values of anatomical parameters for difficult mask ventilation and Impossible mask ventilation among patients who underwent elective surgeries at Wolaita sodo University teaching and referral hospital and sodo Christian hospital in Ethiopia from July 1- August 30, 2017.

3.2. Specific Objectives

1. To determine the predictive values of anatomical parameters for difficult mask ventilation.
2. To assess incidence of difficult mask ventilation.
3. To assess incidence of impossible mask ventilation

4. METHODOLOGY AND MATERIALS

4.1. Study area and period

This study was conducted in WSUTRH and SCH. These hospitals are found in wolaita zone capital city, sodo and are one of the largest teaching hospitals in SNNPR having about 300 beds and 5 operation rooms and 200 beds and 5 operation rooms respectively. Both institutions are well equipped. WSUTRH provides diagnosis and treatment for 15,000- 20,000 patients per year and 2,500 – 3,000 patients undergo surgery in a year and SCH provides diagnosis and treatment for 10,000- 15,000 patients per year and 1,500 – 2,000 patients undergo surgery in a year. The study was conducted from July 1- August 30, 2017.

4.2. Study Design

A facility based cross-sectional study was used.

4.3. Population

4.3.1. Source Population

Surgical patients admitted to wolaita sodo university teaching and referral hospital and sodo Christian hospital.

4.3.2. Study population

Patients who are scheduled for elective surgery under general anesthesia at WSUTRH and SCH from July 1- August 30, 2017.

4.3.3. Study unit

The study units are each patient who underwent elective surgery under general anesthesia.

4.4. Eligibility Criteria

4.4.1. Inclusion criteria

Patients who underwent elective surgery under general anesthesia are included.

4.4.2. Exclusion criteria

The following patients were excluded from this study;

- ✓ **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 and there is no standard measurements of anatomical parameters for those age <18 years.

- ✓ **Psychiatric patients;** because they may not cooperate for the airway assessment.
- ✓ Patients scheduled for **thyroid** and **maxillofacial surgeries**

4.5. Sampling technique and sample size determination

Since there is no evidence that supports the difference on incidence and predictive values of anatomical parameters for difficult mask ventilation in seasons or months, we used a consecutive sampling technique. So, all patients who fulfill the inclusion criteria in the specified time period are included.

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% & d = 5%

$$n = (1.96)^2 \times 0.5 (1-0.5) / (0.05)^2 = 384$$

$n_f = n / (1 + n/N)$, N = 833 (estimated target population in the study period)

So, $n_f = 263$

$$(1 + 384/833)$$

We added 10% of n_f for nonresponse rate; (i.e., $263 + 26 = 286$);

Therefore, a total sample size of **286** elective surgical patients were planned to participate in this study.

4.6. Variables

4.6.1. Dependent variables

- ✓ Difficult mask ventilation

4.6.2. Independent variables

- **Sociodemographic variables:**
 - ✓ Age
 - ✓ sex
 - ✓ ASA physical status
- **Anatomy related variables:**
 - ✓ Interincisor Distance
 - ✓ Modified Mallampati Class
 - ✓ Thyromental Distance
 - ✓ Mandibular Protrusion
 - ✓ Sternomental Distance
 - ✓ Body Mass Index
 - ✓ Dentition
 - ✓ Neck circumference
 - ✓ Neck (atlanto-occipital joint) mobility
 - ✓ History of snoring
 - ✓ Obstructive sleep apnea
 - ✓ Old age
 - ✓ Kyphoscholiosis

4.7. Data collection technique

Structured questionnaire prepared in English and Amaharic was used. During data collection ten, BSc holders and one MSc holder was involved as data collector and supervisor respectively. Patients scheduled for elective surgery under GA was assessed at the waiting room immediately before their entry to the operation room. Then, after preparation all necessary equipments and adequate depth of anesthesia each patient was observed for difficult mask ventilation in the operation room while qualified anesthetist applying mask ventilation and one anesthetist grading mask ventilation according to Han's Mask Ventilation Classification and Description Scale.

4.8. Data quality assurance

One full day training was given for the data collectors and supervisor. During data collection, close supervision and follow up was made. The collected data was cross checked for its completeness, clarity and consistency.

4.9. Data analysis

Data with complete information was entered to SPSS version 20. The descriptive statistics and ROC curve was performed. The validity of parameters (screening tests) such as sensitivity, specificity, positive predictive values and negative predictive values was performed using crosstabs.

4.10. Dissemination and utilization of results

The result will be presented on workshops, Anatomical society of Ethiopia, Ethiopian Association of Anesthetists Annual Conference and Scientific Conferences. It will also be discussed with the health managers of wolaita sodo university teaching and referral 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.

4.11. Operational definitions:

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 (no functional 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 (functionality incapacitated)

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

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

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

Body mass index (BMI) is the body mass divided by the square of the body height, and universally expressed in units of kg per meter square.

< 18.5 Underweight

18.5- 24.5 Normal

25-29.9 Overweight

30-34.9 Obese

35-39.9 severely obese

> 40 morbidly obese

>50 super obese

Kyphosis (hunch back) overinflated thoracic & sacral curves

Scoliosis is exaggerated lateral deviation of 3rd to 6th thoracic vertebrae

Kyphoscoliosis is a deformity of the spine characterized by abnormal curvature of the vertebral column in two planes (coronal and sagittal). It is a combination of Kyphosis and scoliosis.

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

Difficult airway: is defined as the clinical situation in which a conventionally trained Anesthetist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both

Difficult mask ventilation is a situation in which: “It is not possible for the anesthesiologist to provide adequate ventilation because of one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas.”

Classification Description: Han’s Mask Ventilation Classification and Description Scale

Grade 0 Ventilation by mask not attempted

Grade 1 Ventilated by mask

Grade 2 Ventilated by mask with oral airway or other adjunct

Grade 3 Difficult mask ventilation (Inadequate, unstable, or 2 person technique)

Grade 4 Unable to mask ventilate

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 3cm 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 Mallampatti 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.

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.

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 airway.

Surgical patients: are patients who admitted to all available wards in hospital and who undergo surgery.

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 airway.

Obstructive sleep apnea (OSA) is frequent episodes of apnea during sleep, snoring, and daytime symptoms, which include sleepiness, impaired concentration, memory problems, and morning headaches.

4.12. Ethical considerations

Ethical clearance was obtained from Department Research Ethics Review Committee (DRERC). Then, a letter of support and permission was given to the hospital administrators. Informed verbal consent was secured from every study participants. Confidentialities and anonymity was ensured.

5. RESULTS

5.1. Personal socio-demographic characteristics and distribution of mask ventilation

The study was conducted on 278 patients of which 101/278(36.3%) were males and 177/278(63.7%) were females. 8/286 (2.8%) patients were excluded from analysis due to incomplete information. The highest number of cases 57.6% (n=160) were belonged to the age group of 18 – 40. The mean age of our study population was 36.21 ± 10.9 (minimum 18 and maximum 76).

Out of 278 Patients 163(58.6%), 108(38.8), 7(2.5%) were ASA physical status class I, II, and III respectively. There were no cases with ASA physical status class IV or V.

Table 1: Socio-demographic characteristics and distribution of mask ventilation in elective surgical patients who took general anesthesia at WSUTRH and SCH 2017 G.C.

Variable	Category	Frequency	Mask ventilation n (%)			
			Grade			
			I	II	III	IV
Sex	M	101	89(88.1)	9(8.9)	3(3)	-
	F	177	164(92.7)	9(5.1)	3(1.7)	1(0.6)
Age group	18-40	160	153(95.6)	4(2.5)	3(1.9)	-
	41-60	111	97(87.4)	10(9)	3(2.7)	1(0.9)
	≥60	7	3(42.9)	4(57.1)	-	-
ASA physical status	I	163	152(93.3)	10(6.1)	1(0.6)	-
	II	108	97(89.6)	5(4.6)	5(4.6)	1(0.9)
	III	7	4(57.1)	3(42.9)	-	-

5.2. Predictive values of anatomical parameters for difficult mask ventilation

In this study we found the incidence of difficult mask ventilation (grade III) as **2.2 %**(6/278).

Incidence of grade I and II were 91 %(253) and 6.5 %(18) respectively. There was only one case 0.4 %(1/278) with mask ventilation grade IV (impossible mask ventilation), first they tried to

ventilate by using adjuvant and then tried by changing techniques but, when they fail to do they gave the patient muscle relaxant and intubated immediately.

Table 2: Anatomical parameters and their distribution with mask ventilation among elective surgical patients who took general anesthesia at WSUTRH and SCH 2017 G.C.

Parameter	Category	Frequency n (%)	Mask ventilationn (%)			
			Grade			
			I	II	III	IV
IID	< 3cm	1(0.4)	-	1(100)	-	-
	≥ 3cm	277(99.6)	253(91.3)	17(6.1)	6(2.2)	1(.4)
OSA	Present	3(1.1)	-	1(33.3)	2(66.7)	-
	Absent	275(98.9)	253(92)	17(6.2)	4(1.5)	1(.4)
Age	≤55years	268(96.4)	250(93.3)	11(4.1)	6(2.2)	1(.4)
	> 55years	10(4.6)	3(30)	7(70)	-	-
KS	Present	-	-	-	-	-
	Absent	278(100)	253(91)	18(6.5)	6(2.2)	1(.4)
NM	FM	277(99.6)	253(91.3)	17(6.1)	6(2.2)	1(.4)
	Limited	1(0.4)	-	1(100)	-	-
NC	≤40cm	274(98.6)	253(92.3)	17(6.2)	4(1.5)	-
	> 40cm	4(1.4)	-	1(25)	2(50)	1(25)
Dentition	Lost	1(0.4)	-	1(100)	-	-
	Not lost	277(99.6)	253(91.3)	17(6.1)	6(2.2)	1(.4)
HOS	W	5(1.8)	-	2(40)	2(40)	1(20)
	NW	273(98.2)	253(92.7)	16(5.9)	4(1.5)	-
BMI	≤26kg/m2	275(98.9)	253(92)	18(6.5)	4(1.5)	-
	> 26kg/m2	3(1.1)	-	-	2(66.7)	1(33.3)
SMD	< 12cm	4(1.4)	1(25)	2(50)	-	1(25)
	≥ 12cm	274(98.6)	252(92)	16(5.8)	6(2.2)	-
TMD	< 6cm	3(1.1)	-	2(66.7)	-	1(33.3)

	≥ 6cm	275(98.9)	253(92)	16(5.8)	6(2.2)	-
MP	A	270(97.1)	253(93.7)	13(4.8)	3(1.1)	1(.4)
	B	5(1.8)	-	4(80)	1(20)	-
	C	3(1.1)	-	1(33.3)	2(66.7)	-
MMC	I	261(93.5)	244(93.3)	13(5)	3(1.1)	1(.4)
	II	10(3.6)	9(90)	1(10)	-	-
	III	7(2.9)	-	4(57.1)	3(42.9)	-

*IID = Interincisor Distance *OSA = Obstructive Sleep Apnea *KS = Kyphoscoliosis *NM = Neck Mobility *NC = Neck Circumference *HOS = History of Snoring * BMI = Body Mass Index *SMD = Sternomental Distance *TMG = Thyromental Distance * MP = Mandibular Protrusion *MMC = Modified Mallampatti Class

Table 3: Sensitivity, specificity, positive predictive values and negative predictive values for preoperative anatomical parameters against mask ventilation grade III among elective surgical patients who took general anesthesia at WSUTRH and SCH 2017 G.C.

Parameter	Sn%	Sp%	PPV%	NPV%	Area	Accuracy%
Inter incisor distance ^{<} 3cm	0	99.6	0	97.8	.498	49.8
TMD ^{<} 6cm	0	98.9	0	97.8	.494	49.4
SMD ^{<} 12cm	0	98.5	0	97.8	.493	49.3
BMI ^{>} 26kg/m2	33.3	99.6	66.7	98.5	.665	66.5
History of snoring(present)	33.3	98.9	40	98.5	.661	66.1
Dentition(lost)	0	99.6	0	97.8	.498	49.8
Neck circumference ^{>} 40cm	33.3	99.3	50	98.5	.663	66.3
OSA	33.3	99.6	66.7	98.5	.665	66.5
Neck mobility(limited)	0	99.6	0	97.8	.498	49.8
Kyphoscoliosis(present)	-	100	-	97.5	.5	50
Old age ^{>} 55years	0	96.3	0	97.8	.482	48.2

MMC III	50	98.5	42.9	98.9	.743	74.3
Mandibular protrusion B & C	50	98.2	37.5	98.9	.741	74.1

*Sn = sensitivity, Sp = specificity, PPV = positive predictive value, NPV = negative predictive value

From this table we can see that all of the anatomical parameters showed highest specificity and negative predictive value for difficult mask ventilation (grade III).

MMC class III and Mandibular protrusion class B and C followed by OSA, neck circumference > 40cm, history of snoring and BMI > 26kg/m² showed highest accuracy, sensitivity and positive predictive

value (74.3%, 50%, 42.9%), (74.1%, 50%, 37.5%), (66.5%, 33.3%, 66.7%), (66.3%, 33.3%, 50%), (66.1%, 33.3%, 66.7%), (66.5%, 33.3%, 66.7%) respectively to predict difficult mask ventilation grade (III).

Anatomical parameters (IID < 3cm, TMD < 6cm, SMD < 12cm, lost dentition, limited neck mobility, Kyphoscoliosis and old age > 55 years) showed 0 sensitivity and PPV for DMV (grade III).

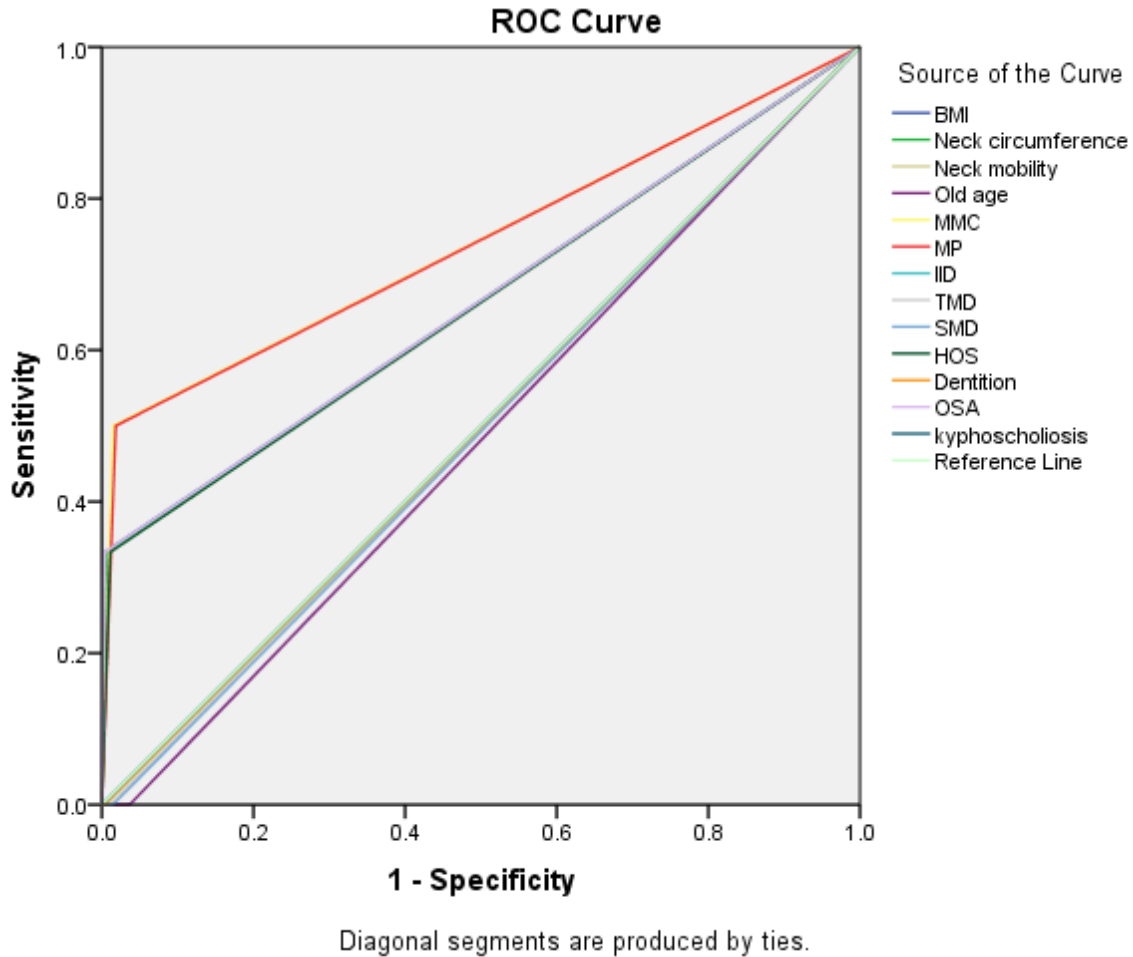


Fig. 1: Receiver operating curve for preoperative anatomical parameters against difficult mask ventilation in the study population

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.

So, receiver operating characteristics curve above revealed that MMC class III, Mandibular protrusion class B and C, $NC > 40\text{cm}$, $BMI > 26\text{kg/m}^2$, OSA and HOS above the reference line (0.5) with the area under the curve (.743, .741, .663, .665, .665, .661) respectively.

6. DISCUSSION

The major findings of this study were; MMC III and Mandibular protrusion class B and C have highest accuracy, sensitivity and positive predictive value for DMV (grade III) when compared with other anatomical parameters. In addition, as ROC curve indicated this parameters showed the area under the curve above 0.5(reference line).So, this means MMC III and Mandibular protrusion class B and Care good predictors for DMV (grade III). Our finding is comparable with **(Prerana N Shah, 2012)**who found history of Snoring, obstructive sleep apnea, retrognathia, micrognathia, macroglossia, short thick neck, Mallampatti grade [III/IV] grade, and BMI > 26 kg/m² as predictors for DMV. Whereas, in our study anatomical parameters like, IID < 3cm, TMD < 6cm, SMD < 12cm, lost dentition, limited neck mobility, Kyphoscoliosis and old age > 55years showed 0 sensitivity and Positive predictive value for DMV(grade III) which was comparable with similar studies performed by **(Shah P, 2012)**.

In this study, we found the incidence of difficult mask ventilation (grade III) as 2.2 % (6/278). There is a wide variation in the reported incidence of DMV in the literature. Whereas one study reported an incidence as low as 0.08%, another reported a 15% incidence. The highest incidence (15%) was reported from a retrospective study of subjects who had difficult intubation. The majority of prospective studies, on the other hand, reported a lower incidence. 0.9% **(Rose and Cohen., 1994)**, 1.4% **(Prerana N Shah, 2012)**, 5% **(Langeron O et al., 2000)**, and 7.8% **(Yildiz T et al., 2005)**. The large prospective study of 22,660 MV attempts used a DMV grading scale and reported an incidence of 1.4%. Because this is the large and most recent study and because the reported incidence is in agreement with several other studies 1.4% may be considered the most likely estimate in the general population **(Kheterpal S et al., 2006)**.

Our result is almost similar to the one which was done on large prospective study of 22,660 even if there is a little difference. So, the probable explanation for this difference result may be because of differences in the population characteristics.

In this study highest percent of DMV was occurred in patients with OSA, BMI > 26kg/m², Mandibular protrusion class C followed by Neck circumference > 40cm, history of snoring, MMC III and Mandibular protrusion class B. We found IID < 3cm, old age > 55years, Kyphoscoliosis, limited neck mobility and lost dentition have no relation with DMV.

Similarly In a prospective study of 1502 patients, (**Langeron O et al., 2000**) performed a multivariate analysis and found five anatomical risk factors to be significantly associated with DMV and thus may be used as predictors. These were: age older than 55 yr, body mass index (BMI) more than 26 kg/m², lack of teeth, history of snoring, and presence of a beard. The presence of at least two of these factors indicated a high likelihood of DMV. Similarly, an analysis by(**Yildiz T et al., 2005**) found age, weight, history of snoring, male gender, and Mallampatti Class IV to be significantly associated with DMV.

Our data also indicated DMV is higher in male than female patients; this finding is consistent with those of other studies. For example, (**Yildiz T et al., 2005**) found that the male gender was an independent risk factor for DMV. In theory, the differences in bone structure, soft tissue and fat deposition in males compared with females creates a tendency for upper airway collapse in males. Similarly, the activation or control of pharyngeal dilator muscles in males can lead to pharyngeal collapse. The difference in respiratory control mechanisms between the genders is also used to explain why male patients are prone to obstructive sleep apnea syndrome (**Malhotra A et al., 2002**). Thus, being male appears to be a predisposing factor for airway collapse, which can increase the difficulty of mask ventilation.

In our study a total of 278 patients were investigated and only one case with impossible mask ventilation (grade IV) was encountered. A study by (**Kheterpal S et al., 2006**) on 22,660 patients found the rate of grade IV as 0.16% (n=37), while another study by the same researcher identified the rate of grade IV as 0.15% (n=77) in 53,041 patients given mask ventilation (**Kheterpal S et al., 2009**). In a study of 576 patients by (**Yildiz T et al., 2005**) they stated they did not encounter grade IV MV. When the literature is examined, these studies were completed on very broad patient series and we see the rate of grade IV MV is very low.

In our study, impossible mask ventilation (Grade IV) was occurred in patients with Neck circumference > 40cm, history of snoring, BMI > 26kg/m², TMD < 6cm, SMD < 12cm.

We found IID < 3 cm, old age > 55years, Kyphoscoliosis, limited neck mobility and lost dentition have no relation with IMV. History of snoring and limited neck mobility, Thyromental distance are risk factors for impossible mask ventilation (**Kheterpal S et al., 2009**). In our study, IID

3cm, old age > 55years, limited neck mobility and lost dentition showed no relation with DMV or IMV.

7. STRENGTH AND LIMITATION OF THE STUDY

7.1. Strengths

The strengths of the research were:

- 1) As to my knowledge, there was no research done on the predictive values of anatomical parameters and incidence of difficult mask ventilation in our country. Therefore, it can help as a baseline data for researchers and stake holders.
- 2) Most of the researches done on predictive values of anatomical parameters used few variables but, in our research we used about thirteen variables.

7.2 Limitations

The limitations of our study were:

1. Our study was done only on those patients whose age was above 18 years. Those patients whose age below 18 years was excluded from the study
2. We used Small sample size;it was difficult to get association.

8. CONCLUSION AND RECOMMENDATION

8.1. Conclusion

- ❖ MMC class III and Mandibular protrusion class B and Care good predictors of difficult mask ventilation (grade III).
- ❖ Anatomical parameters like HOS, TMD < 6cm, Neck circumference > 40cm, BMI > 26kg/m² and SMD < 12cm are related with IMV (grade IV)
- ❖ IID < 3cm, lost dentition, limited NM, Kyphoscoliosis and old age > 55years are not related with DMV (grade III) or IMV (grade IV).
- ❖ Anatomical parameters like IID < 3cm, limited NM, lost dentition, MP class B, old age > 55years and TMD < 6cm are related with mask ventilation grade II.
- ❖ NC > 40cm, BMI > 26kg/m² and HOS are related with both DMV and IMV.

8.2. Recommendation

Preoperative assessment of patients for prediction of difficult mask ventilation is very important to have meticulous preparation that will help in challenging difficulties when they arise.

- ✓ Anesthetist is recommended to do preoperative assessment on patients and to identify patients at risk of DMV.
- ✓ Researchers are recommended to do further research by including other age groups and by using large sample size.
- ✓ Health facilities were recommended to make sure that the presence of fully equipped facilities and well trained health professionals to manage the difficult mask ventilation and minimize morbidities and mortalities associated with difficult mask ventilation.

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ANNEXS

ANNEX -I: CONSENT FORM

Predictive values of anatomical parameters for difficult mask ventilation among Surgical Patients who underwent elective Surgery under General Anesthesia from July 1 –August 30, 2017.

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

This questionnaire is to assess predictive values of anatomical parameters for difficult mask ventilation among surgical patients. The main concern of this study was to fill the information gap on predictive value of anatomical parameters for estimating difficult mask ventilation 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. 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 0913376477.

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

Thank you for your participation!

ANNEX –II: QUESTIONARIES

Part I: Identification

Age	
Sex	A. Male B. Female
ASA status	A. I B. II C. III D. IV E. V

Part Two: Assessment for Difficult Mask ventilation

NO	Variables	Classification
1	Interincisor Distance	A. $< 3\text{cm}$ B. $\geq 3\text{cm}$
2	Mallampatti Class	I II III IV
3	Mandibular Protrusion	A B C
4	Thyromental Distance	A. $< 6\text{cm}$ B. $\geq 6\text{cm}$
5	Sternomental Distance	A. $< 12\text{cm}$ B. $\geq 12\text{cm}$
6	BMI	A. $\leq 26 \text{ Kg/m}^2$ B. $> 26 \text{ Kg/m}^2$
7	History of Snoring	A. Witnessed B. Not Witnessed
8	Dentition	A. Lost B. Not lost
9	Neck circumference	A. $\leq 40 \text{ cm}$ B. $> 40 \text{ cm}$
10	Obstructive Sleep Apnoea	A. Present B. Absent
11	Neck mobility	A. Freely movable B. Limited
12	Old age	A. $\leq 55 \text{ years}$ B. $> 55 \text{ years}$
13	Kyphoscoliosis	A. Present B. Absent
14	Mask ventilation	A. Grade I B. Grade II C. Grade III D. Grade IV

