e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.10.97

International Journal of Pharmaceutical Quality Assurance 2025; 16(10); 632-639

Original Research Article

Evaluation of Body Mass Index as a Predictor of Difficult Airway Management During General Anesthesia

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Received: 13-08-2025 / Revised: 10-09-2025 / Accepted: 20-10-2025

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Conflict of interest: Nil

Abstract:

Background: Upper airway anatomic and physiology changes causes airway problems which are one of the important risk factors of airway management in general anesthesia in case of obesity.

Aim: To study if there is any association between the BMI and difficulty of airway management in general anesthesia.

Methodology: Study was performed in 120 patients who had planned elective surgeries under general anesthesia for one year in ICARE Institute of Medical Sciences and Research & Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal, India

Results: In 120 patients 16.7% patients have difficult intubation of which 40.9% patients were obese. Laryngoscopy (Grade III & IV) were more frequently seen in obese patients (45.5%). Airway management is statistically significantly associated with BMI ($p<0.05$). Higher BMI was found to be significantly associated with difficult airway management and difficult view during laryngoscopy.

Conclusion: The BMI has significant association with difficult airway management and difficult view during laryngoscopy.

Keywords: Body Mass Index, Difficult Airway, General Anesthesia, Difficult Intubation, Obesity, Laryngoscopy.

Introduction

Among many tasks that has to be carried out by anesthesiologist in the administration of general anesthesia, managing the airway is a significant responsibility [1]. If the airway management failed, difficult endotracheal intubation could cause a wide range of complication in per operative period, including hypoxia, aspiration, airway injury, cardiovascular events, even the death [2]. So, it has become of paramount importance to guarantee the airway safety in case of airway obstruction, and that will be achieved by predicting the risk factors of difficult airway management before the induction of anesthesia. Anatomic and physiological conditions which result in the difficulty of airway management may include, for example, obesity, limited neck motion, restricted mouth opening, abnormal airway structure [3].

Body mass index (BMI) has been a subject of much interest as a cause of airway management related problems. Excessive soft tissue deposition in the neck and upper airway, a reduction in lung compliance, restricted mobility of the neck and reduced visual access during laryngoscopy are a consequence of high BMI, particularly obesity [4]. Such features are likely to increase the risk of developing airway management complications. Numerous scientific publications suggest the existence of a positive association between airway management difficulties and obesity, but its magnitude is subject to variation [5].

Various preoperative assessments of the airways' condition (Mallampati test, thyromental distance, mouth opening capacity, and Cormack-Lehane test), are used in practice to predict airway management difficulty in surgical patients [6]. Nevertheless, the value of these parameters as airway predictors may depend on the BMI, among other patient-specific characteristics. Identification of high-risk patients will allow for successful airway management and reduce risks at an early stage [7].

The aim of the present study is therefore to study the correlation of BMI with difficulty in airway management in patients who underwent general anesthesia. Additionally, the aim of the study is to

estimate the rate of airway difficulty based on the type of BMI and its connection with airway evaluation parameters.

Background of the Study

The growing occurrence of overweight and obesity has posed serious problems in health issues and affected perioperative anesthetic practice substantially [8]. Obesity leads to many structural and physiologic changes, such as increased fat deposit on the upper airway space, reduced functional residual capacity, lack of neck movement, and poor pulmonary dynamics, all of which might result in difficult airway management when performing general anesthesia. Difficult tracheal intubation and mask ventilation are common factors that cause complications and death associated with anesthesia. Thus, it is necessary to timely recognize high-risk patients with difficult airways [9]. The Body Mass Index (BMI) is one of the measures to determine obesity. Besides, it has been assumed to be a possible predictor of difficult airway management [10]. Despite many attempts to establish a connection between obesity and difficulty with airway management, further research is needed because of differences in patient population and medical settings [11]. In order to examine this issue, the current study was designed to explore the correlation between BMI and difficulty of airway management in patients who are operated under general anesthesia.

Association of BMI with Difficult Airway Management Under General Anesthesia: BMI is known to be crucial in determining the level of difficulty in the management of airway during surgeries done using general anesthesia [12]. The increased BMI especially in overweight and obese patients is known to be associated with deposition of excess soft tissues in the neck and upper airways, decreased range of movement of the neck, restricted opening of the mouth, and difficulty in intubation [13]. These physical characteristics can contribute to the difficulty in mask ventilation, difficult tracheal intubation, repeated intubations, and other complications related to airway management [14]. The current study demonstrates that obese patients had a significantly higher frequency of difficult intubation and poor Cormack-Lehane grades than those with normal BMI.

Research Objectives

The objectives of the study are:

- To evaluate the association between BMI and airway management difficulty in patients undergoing surgery under general anesthesia.
- To assess the incidence of difficult intubation and difficult mask ventilation among patients with different BMI categories.
- To determine the relationship between BMI and laryngoscopic view based on Cormack-Lehane grading during direct laryngoscopy.
- To analyze preoperative airway assessment parameters such as Mallampati grading, thyromental distance, and mouth opening in predicting difficult airway management among patients with varying BMI levels.

Methodology

This current research work aims at establishing a link between the Body Mass Index (BMI) and airway difficulties encountered during surgical procedures performed under general anesthesia. Different factors such as demographics, anthropometrics, and airway examinations were considered for their correlation with difficult airways.

Study Design: This study was performed using the hospital-based, prospective observational study approach. This study used systematic collection of data among patients who have undergone elective surgeries under general anesthesia.

Study Area: This investigation was carried out in Department of Anaesthesiology, ICARE Institute of Medical Sciences and Research & Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal, India

Study Duration: The study was conducted over a period of one year.

Study Participants: Participating adults were all set to undergo elective general anesthesia-based surgical procedures that necessitated endotracheal intubation.

Inclusion Criteria

- Patients from 18 to 65 years old.
- Patients of either gender.
- Some patients who are set to have planned surgery and need to be put on a breathing tube while they're under general anesthesia.
- People who agreed to be part of the study and signed a form to say it was okay.
- ASA (American Society of Anesthesiologists) physical status I and II patients.

Exclusion Criteria

- Patients who suffer from congenital respiratory anomalies.
- People with injuries in the face or facial deformities.
- Patients whose cervical spines are unstable or who cannot move their neck adequately.
- Patients with lesions or infections in their upper airway.
- Pregnant women.
- Patients unwilling to participate in the study.

Sample Size: The investigation included 120 patients who were recruited using a straightforward sampling procedure. There was enough work going on at the time to warrant a sufficient sample size for analyzing the correlation between BMI and airway management difficulty.

Procedure: The subjects, extensive pre-anesthetic evaluations were performed on all patients meeting the inclusion criteria.

The demographic characteristics of age, gender, height, weight, and BMI were collected. The calculation of BMI was done using the formula:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Patients were classified based on the BMI into four categories, which include underweight, normal weight, overweight, and obese, based on WHO Classification.

Mallampati score, thyromental distance, mouth opening, neck circumference, and sternomental distance were some of the airway examination measures used. During the procedure, it was established that mask ventilation and intubation were challenging.

All patients were given medication in advance under the protocol of the facility. The patient underwent standard monitoring prior to anesthetic induction, which included an electrocardiogram (ECG), pulse oximeter, non-invasive blood pressure monitoring, and capnography. Conventional methods of induction were employed to induce anesthesia.

Laryngoscopy was done using Macintosh laryngoscope by a trained anesthesiologist. Laryngoscopy view was determined by Cormack-Lehane classification. Information regarding difficulty in mask ventilation, attempts for intubation, airway devices used, time taken for intubation, and complications experienced was recorded.

Difficult intubation was considered when more than two attempts were made, other airway measures had to be taken, and when Cormack-Lehane III and IV views occurred.

Statistical Analysis: Statistical Package for the Social Sciences (SPSS) Version 25.0, hosted on the Microsoft Excel spreadsheet program, was used to analyze the obtained data. The Mean ± Standard Deviation was used to evaluate continuous variables, whilst frequencies and percentages were employed for categorical variables.

To examine the correlation between BMI classes and difficulty in executing airway control at a p-value less than 0.05, categorical variables were analyzed using the Chi-square test, while continuous variables were analyzed using the student's t-test.

Results

120 patients, who were scheduled for surgery under general anesthesia were included in the study. Demographic data, BMI of the patients, examination findings of the airways and difficulty in the operating room in performing airway management were used as the basis of the analysis.

Table 1: Demographic Characteristics of Study Participants (n = 120)

Variables	F	%
Age Group (Years)		
18–30	28	23.3%
31–45	46	38.3%
46–60	34	28.3%
>60	12	10.0%
Gender		
Male	68	56.7%
Female	52	43.3%
ASA Physical Status		
ASA I	72	60.0%
ASA II	48	40.0%

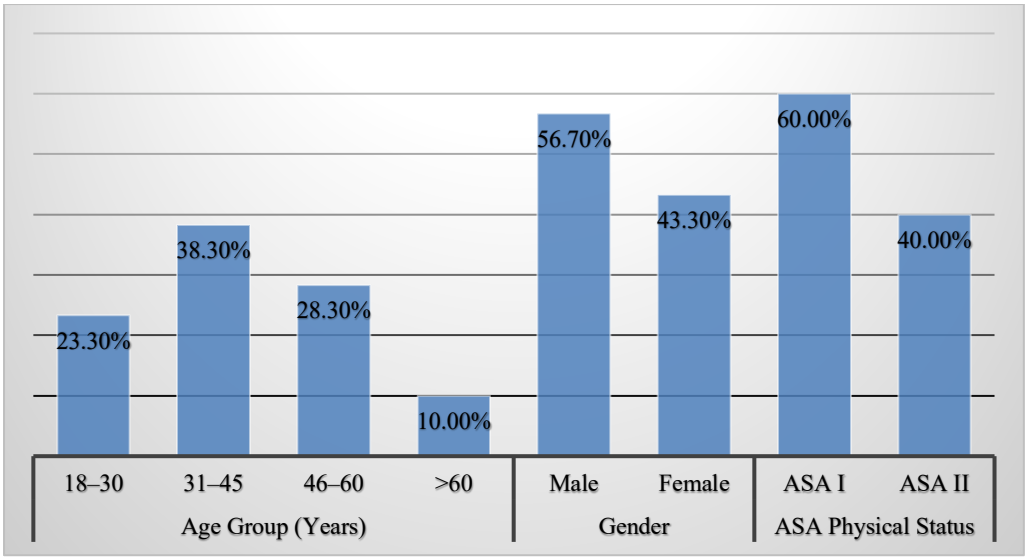

Figure 1: Visual Representation of Demographic Characteristics of Study Participants

From the 120 participants in the study, it was observed that most of the patients fell in the age range of 31-45 years (38.3%) and secondly, 46-60 years (28.3%). Male participants formed 56.7% of the total sample, whereas female patients were 43.3% of the total sample size. Mostly, patients had an ASA status of one (60%), which indicates a stable pre-surgery health condition of patients.

Table 2: Distribution of Patients According to BMI Categories

BMI Category	F	%
Underweight (<18.5 kg/m²)	8	6.7%
Normal Weight (18.5–24.9 kg/m²)	52	43.3%
Overweight (25–29.9 kg/m²)	38	31.7%
Obese (≥30 kg/m²)	22	18.3%

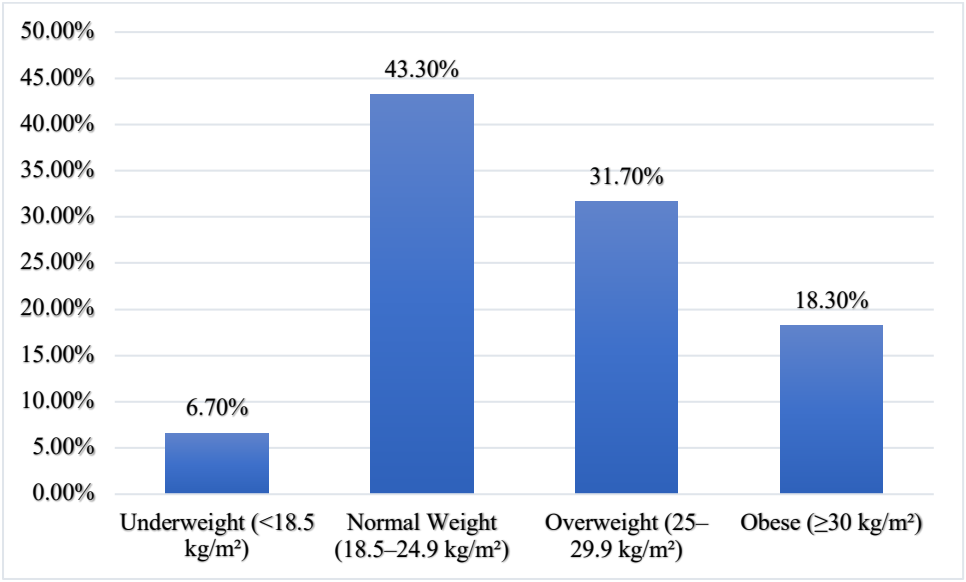

Figure 2: Visual Representation of Distribution of Patients According to BMI Categories

Results for BMI distribution showed that 43.3% had normal body mass, 31.7% had a body mass index (BMI) of being overweight, while 18.3% of patients were obese. There were only 6.7% of patients who were found to be underweight. Overweight and obesity were present in almost 50% of the sample subjects, implying a high burden of increased body mass indices among surgical patients. This large proportion of overweight and obese subjects made up an adequate sampling size for analysis.

Table 3: Preoperative Airway Assessment Findings

Airway Parameters	F	%
Mallampati Grade		
Grade I	42	35.0
Grade II	48	40.0
Grade III	24	20.0
Grade IV	6	5.0
Thyromental Distance		
≥6.5 cm	98	81.7
<6.5 cm	22	18.3
Mouth Opening		
Adequate (>3 fingers)	104	86.7
Restricted	16	13.3

The assessment done preoperatively for the airway showed that the highest proportion among the four classes of patients was Mallampati Class II at 40% incidence. Both the Mallampati Class III and Class IV, showing difficult airway management, comprised 25% of the patients' percentage. Decreased thyromental distance, measured at less than 6.5 cm, occurred in 18.3%, while limited mouth opening was evident in 13.3% of the patients.

Table 4: Intraoperative Airway Management Outcomes

Parameters	F	%
Difficult Mask Ventilation	18	15.0%
Difficult Intubation	20	16.7%
Cormack-Lehane Grade I	54	45.0%
Cormack-Lehane Grade II	42	35.0%
Cormack-Lehane Grade III	18	15.0%
Cormack-Lehane Grade IV	6	5.0%
Multiple Intubation Attempts (>2)	14	11.7%
Use of Airway Adjuncts	16	13.3%

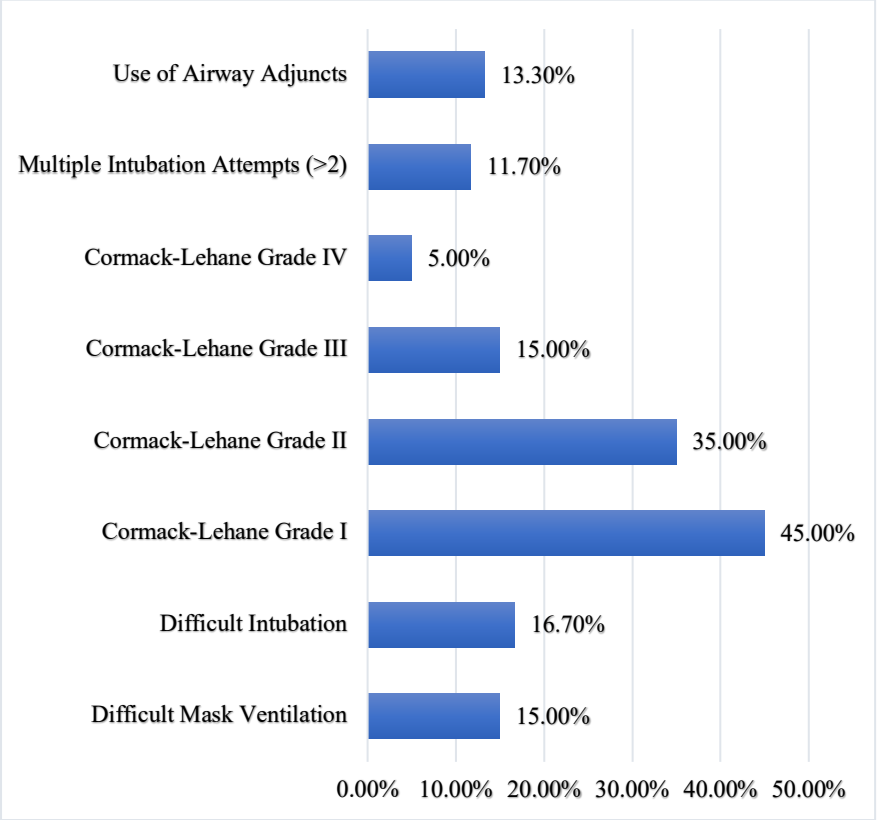

Figure 3: Visual Representation of Intraoperative Airway Management Outcomes

The preoperative airway evaluation revealed that the most common class among the four groups was Mallampati Class II, with a frequency of 40%. The Mallampati Class III and Class IV, which indicate a difficult airway management scenario, were seen in 25% of patients. A decreased thyromental distance of <6.5 cm was seen in 18.3% of patients, and limited mouth opening was seen in 13.3% of the subjects studied.

Table 5: Association Between BMI and Difficult Intubation

BMI Category	Difficult Intubation Present n (%)	Difficult Intubation Absent n (%)	p-value
Underweight	1 (12.5)	7 (87.5)	0.003*
Normal Weight	4 (7.7)	48 (92.3)	
Overweight	6 (15.8)	32 (84.2)	
Obese	9 (40.9)	13 (59.1)	

There existed a statistically significant relationship between BMI and difficult intubation (p = 0.003). According to the results, obese patients had the maximum prevalence of 40.9% whereas overweight and normal and underweight patients had a prevalence of 15.8%, 7.7 % and 12.5% respectively. The results showed a progression in the level of difficulties with airway management with increased BMI. There seems to be a role for obesity in predicting difficult intubation for patients undergoing surgery under general anesthesia. There was statistical significance between increasing BMI and difficult intubation.

Table 6: Association Between BMI and Cormack-Lehane Grade

BMI Category	Grade I-II n (%)	Grade III-IV n (%)	p-value
Underweight	7 (87.5)	1 (12.5)	0.001*
Normal Weight	48 (92.3)	4 (7.7)	
Overweight	30 (78.9)	8 (21.1)	
Obese	12 (54.5)	10 (45.5)	

It was shown that there is statistical significance in the correlation between BMI and Cormack-Lehane scoring system (P = 0.001). Among obese people, about 45.5% had poor laryngoscopy scores (Grade III–IV) while just 7.7% among those who are normal in weight had such results. On the other hand, more than 87.5% of underweight and 92.3% of normal weight individuals had good scores (Grade I–II). In conclusion, the higher the BMI, the poor is the quality of the glottis seen during laryngoscopy making the airway difficult to manage.

Discussion

In the present study, the relationship between BMI and difficult airway management in patients undergoing surgeries under GA was examined. It was established that there was a significant occurrence of difficult intubation among the patients having BMI above 30 kg/m2 compared to those having normal BMI. It was noted that the patients belonging to the obese category were observed to have difficult intubation in 40.9%, whereas normal weight people showed 7.7% of difficult intubations. Moreover, patients with obesity had a significantly higher frequency of Grade III–IV Cormack-Lehane views (45.5%). These results were supported by a meta-analysis performed by T Wang et al. (2018) [15]. Authors found a statistically significant relationship between obesity and difficult intubation with the help of direct laryngoscopy. In their systematic review, researchers suggested that high BMI increases the difficulty of airway management due to anatomic abnormalities and decreased space in the upper airway. Also, obesity is mentioned as an important factor of difficult intubation by A De Jong et al. (2015) [16].

In addition to BMI, some preoperative airway parameters such as Mallampati grade, thyromental distance, and mouth opening were assessed in the present study. High Mallampati grades (III and IV) were detected in 25% of patients, being more common in overweight and obese people. This finding corresponds to research by AA Uribe et al. (2015) [17] which suggests that obese patients tend to have a difficult tracheal intubation, especially if males undergo surgeries under general anesthesia. Similar results are presented by B Thota et al. (2022) [18] who stated that obese people show anatomical changes in the airway, e.g., enlarged neck circumference, reducing the possibility of laryngoscopy. Consequently, preoperative airway assessment should be performed in obese surgical patients to avoid possible complications.

According to the current study results, difficult mask ventilation was revealed in 15% of patients, while multiple attempts at intubation and application of airway devices were needed in 11.7% and 13.3% of cases, respectively. Such a correlation implies that the increase in BMI makes airway management during general anesthesia more complicated. This hypothesis was supported by F Larson et al. (2019) [19] who pointed out that obesity creates additional difficulties in the process of airway management and

anesthetics delivery due to some physiological and anatomical factors. Additionally, R Seyni-Boureima et al. (2022) [20] stated in their review that obese patients have more problems with anesthesia administration as well as airway management and may suffer from perioperative hypoxemia.

Conclusion

This current research revealed that an elevated body mass index (BMI) score is significantly linked to difficult airway management among patients who have undergone surgery while under general anesthesia. Patients having high BMI scores had a very significant difficulty in being intubated. They also scored poorly in terms of Cormack-Lehane grading during laryngoscopy. Moreover, difficult mask ventilation and the need for repeated intubations were observed among these patients. In addition, the researchers found that various pre-anesthetic assessment measures like Mallampati classification, thyromental distance, and mouth opening also indicated a difficult airway. It can thus be noted from the results of this research that obesity plays a very crucial role in difficult airway management.

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