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Original Research Article

# A Comparative Study of Predictive Factor for Difficult Mask Ventilation in Adult Overweight and Obese Population

**Trushna Rahul Talware[1], Amruta Pingale[2], Sunita Sankalecha[3], Jeetendra Singh[4]**

[1]Junior Resident 3, Department of Anaesthesia, Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik-422003, India

[2]Assistant Professor, Department of Anaesthesia, Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik-422003, India

[3]Professor and Head Department of Anaesthesia, Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik-422003, India

[4]Jeetendra Singh, Professor and Head, Department of Pharmacology, Dr. Vasantrao Pawar Medical College, Hospital and Research Centre, Nashik-422003, India

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**Corresponding author: Dr. Amruta Pingale**
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## Abstract

The incidence of DMV in obese individuals has been reported to be 1.4-24%. According to World Health Organization data, in 2019, there were more than 1.9 billion overweight adults worldwide, above the age of 18, and more than 600 million obese people. Thus, most patients requiring anesthesia for surgery will be overweight or obese.

Observations were made during the study:

-Incidence of difficult airway was observed in 16.3% obese cases as compared to none in overweight individuals.

-Mean BMI was significantly higher among cases with incidence of difficult airway (29.12 vs 26.6 Kg/m$^2$; p<0.01).

-Mean neck circumference was significantly higher among cases with incidence of difficult airway

-Difficult mask ventilation was significantly associated with increasing obesity as seen with its positive correlation with BMI and neck circumference.

**Keywords:** Overweight, obese, mask ventilation.



## Introduction

Bag mask ventilation commonly precedes the establishment of a secure airway by endotracheal intubation. However, the degree of difficulty encountered is variable [1-4], with the incidence of Difficult Mask Ventilation (DMV) varying from 0.08–15% depending on the criteria used for the definition.

According to the American Society of Anesthesiologists (ASA), DMV is defined as a situation where it is not possible for the unassisted anesthesiologist to maintain the oxygen saturation > 90% using 100% oxygen and positive pressure ventilation, or to prevent or reverse signs of inadequate ventilation, because of one or more of the following problems: inadequate mask seal, excessive gas lead or excessive resistance to the ingress or egress of gas [5].

Subsequently, many other definitions have evolved taking into account patient-independent factors that contribute to DMV, such as provider--and equipment-related factors [5]. Moreover, as an effort to overcome subjective definitions, several grading scales have been proposed, including Adnet's and Han's scales [1,6].

In the face of DMV, critical hypoxemia may rapidly ensue and emphasizes the need for proper identification of risk factors during the preoperative assessment.

Obesity is generally acknowledged as a global phenomenon that increases morbidity and reduces life expectancy [7]. According to World Health Organization data, in 2019, there were more than 1.9 billion overweight adults worldwide, above the age of 18, and more than 600 million obese people. Thus, most patients requiring anesthesia for surgery will be overweight or obese [8,9].

The Fourth National Audit Project on major complications of airway management in the United Kingdom reported that obese patients had double the risk of airway problems and morbidly obese patients were four times more likely to develop airway problems during an anaesthetic [10]. In obese patients, not only the external airway but also the anatomy of the oropharynx and larynx is altered. Without regard to the total body fat of obese patients, parapharyngeal fat dimensions increase in parallel with visceral and abdominal fat distribution.

Obesity is related to restrictive pulmonary disease due to increased intraabdominal pressure. This reduces functional residual capacity, causing low oxygen reserves, disrupted gas exchange and shortened safe apnea time before desaturation. As a result, it is known that there is a limited duration to solve airway problems in "can't intubate, can't ventilate" situations [11-13].

In obese patients, difficult airway management, especially difficult mask ventilation (DMV), is frequently reported [14]. The incidence of DMV in obese individuals has been reported to be 1.4-24% [14-16].

In light of the above discussion, present study aimed to determine the prevalence and predisposing factor of difficult airway during induction of general anaesthesia in obese and overweight individuals.

**Difficult Mask Ventilation (DMV)**

**Definition**

At present, there is no standard definition for DMV that is based on precise and objective criteria. The current lack of an objective definition creates problems when clinicians attempt to communicate clinical information. It also complicates data interpretation and comparisons when investigators want to study the subject. Conversely, the subjective and operator dependent nature of the ability to perform MV may render establishing such a precise and objective definition an unreachable goal [17].

In its original report in 1993, the American Society of Anesthesiologists (ASA) Task Force on Management of the Difficult Airway suggested the following definition: "DMV is a situation that develops when it is not possible for the unassisted anesthesiologist to maintain the oxygen saturation >90% using 100% oxygen and positive pressure ventilation, or to prevent or reverse signs of inadequate ventilation." [18]

Because this definition is vague, the Task Force urged clinicians and investigators to use explicit descriptions of difficult airway situations and expressed its desire to develop descriptions that can be categorized or expressed in numerical values. Because inadequate ventilation should not be defined purely in terms of oxygenation, the definition was modified in the Task Force's updated report that was published in 2003. In that report, DMV was defined as "the clinical situation that develops when it is not possible for the anesthesiologist to provide adequate MV due to one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas." [19]

In 2004, Han et al. [24] proposed a grading scale for the ability to perform MV similar to that used for grading the laryngeal view during direct laryngoscopy. Han's scale included four grades in ascending difficulty in which Grade 1 patients are those who can be ventilated easily, and Grade 4 are those who are impossible to ventilate (Table 2).

For the purpose of risk stratification, the scale helps to segregate two groups of patients. Although Grade 1 and 2 patients usually do not raise significant clinical concern, Grade 3 and 4 patients are likely to be at increased risk of inadequate ventilation after anesthesia induction.

**Table 1: Han's Mask Ventilation Classification and Description Scale**

| Classification | Description/definition |
|---|---|
| Grade 0 | Ventilation by mask not attempted |
| Grade 1 | Ventilated by mask |
| Grade 2 | Ventilated by mask with oral airway or other adjuvant |
| Grade 3 | Difficult mask ventilation (inadequate, unstable, or requiring two practitioners) |
| Grade 4 | Unable to mask ventilate |

## Material and Methods

### Study Area

Department of Anaesthesia at tertiary health care centre attached to medical college.

### Study Population

Obese/ Overweight individuals posted for surgical procedures under general anaesthesia.

### Study Design

A Prospective, Comparative study

### Sample Size

Formulae Used: $n= (Z_{\alpha/2} + Z_{\beta})^2 \times PQ * 2 / d^2$

**n- 43 patients per group**

### Study Duration

August 2019 to December 2021

### Inclusion Criteria

1. Patient of age 18 - 60 years
2. Patients who gave written informed consent.
3. Patients with BMI>23

### Exclusion Criteria:

1. Patient with cervical spine fracture
2. Patient with facial fracture
3. Paediatrics patients

### Methodology

- Study was commenced after permission from institutional ethical committee.
- Written informed consent was obtained from all cases.
- Body mass Index (BMI), Modified Mallampati grade, Thyromental distance ratio, history of Obstructive Sleep Apnea, status of teeth and Neck Circumference (NC) were recorded preoperatively in all cases.
- Difficult mask ventilation (DMV) was defined as Grade 3 or above by the Han's scale[8] (mentioned below).

**Table 2: Han's Mask Ventilation Classification and Description Scale**

| Classification | Description |
|---|---|
| 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 MV (inadequate, unstable, or 2 person technique) |
| Grade 4 | Unable to mask ventilate |

### Statistical Analysis

All the data was noted down in a pre-designed study proforma. Qualitative data was represented in the form of frequency and percentage. Association between qualitative variables was assessed by Chi-Square test with Continuity Correction for all 2 X 2 tables and Fisher's exact test for all 2 X 2 tables. Quantitative data was represented using Mean ± SD. Analysis of Quantitative data between the two groups was done using unpaired t-test if data passed 'Normality test' and by Mann-Whitney Test if data failed 'Normality test'. A p-value < 0.05 was taken as level of significance. Results were graphically represented where deemed necessary. SPSS Version 21.0 was used for most analysis and Microsoft Excel 2010 for graphical representation.

### Results

**Table 1: Distribution of cases as per study group**

| Group | N | % |
|---|---|---|
| **Overweight** | 43 | 50.0% |
| **Obese** | 43 | 50.0% |
| **Total** | 86 | 100.0% |

Present study included a total of 86 cases (43 each were overweight and obese) undergoing procedures requiring general anaesthesia.

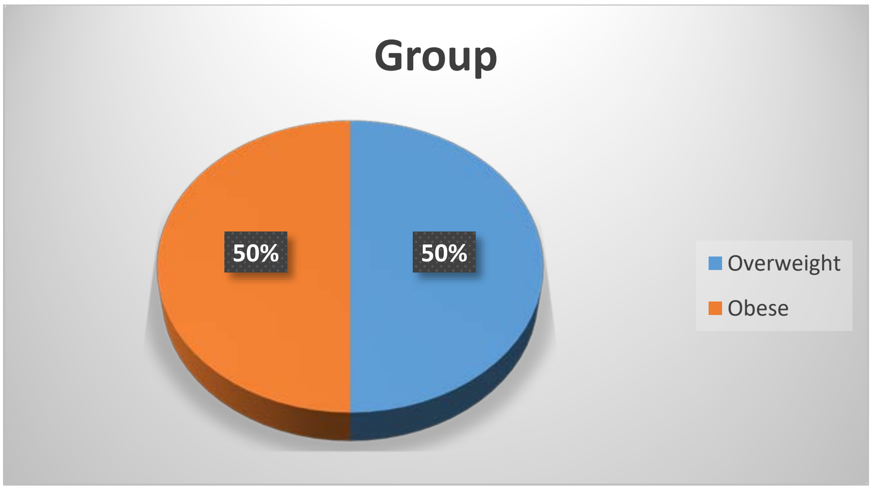



**Table 2: Distribution of study groups as per age**

| Age Group | Group | | Total |
|---|---|---|---|
| | Overweight | Obese | |
| **<=30 yrs** | 12 | 16 | 28 |
| | 27.9% | 37.2% | 32.6% |
| **31-40 yrs** | 7 | 6 | 13 |
| | 16.3% | 14.0% | 15.1% |
| **41-50 yrs** | 10 | 11 | 21 |
| | 23.3% | 25.6% | 24.4% |
| **51-60 yrs** | 14 | 10 | 24 |
| | 32.6% | 23.3% | 27.9% |
| **Total** | 43 | 43 | 86 |
| | 100.0% | 100.0% | 100.0% |
| **p- value - 0.71** | | | |

Most of the study subjects in both groups were in the age range of 31 to 50 years (39.5%) followed by 30 years or younger (32.6%).

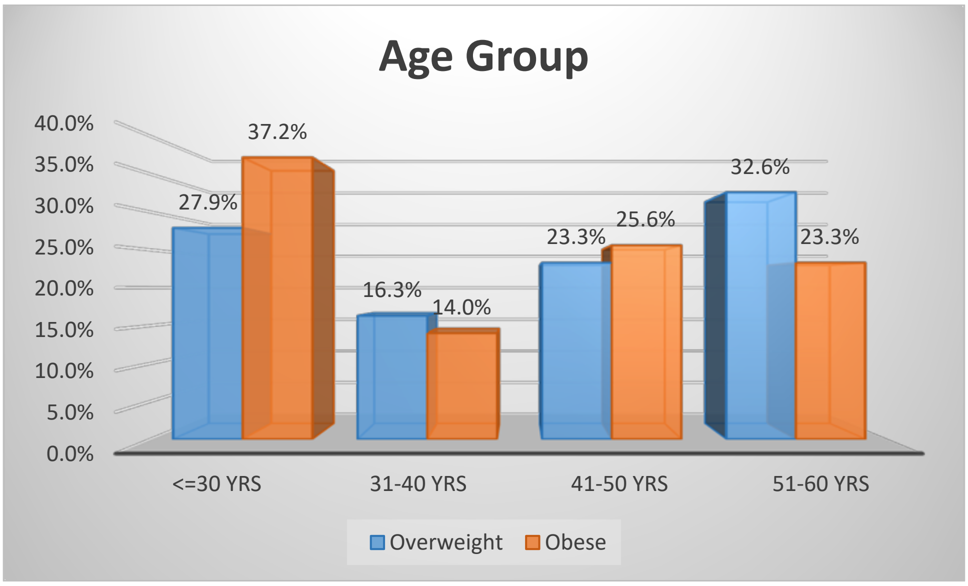


**Table 3: Mean age comparison among study groups**

| Variables | Group | N | Mean | SD | p- value |
|---|---|---|---|---|---|
| **Age (yrs.)** | **Overweight** | 43 | 42.05 | 12.39 | **0.215** |
| | **Obese** | 43 | 38.49 | 13.95 | |

Mean age of the obese individuals was 42.05 years while that of overweight was 38.49 years (p-0.215).

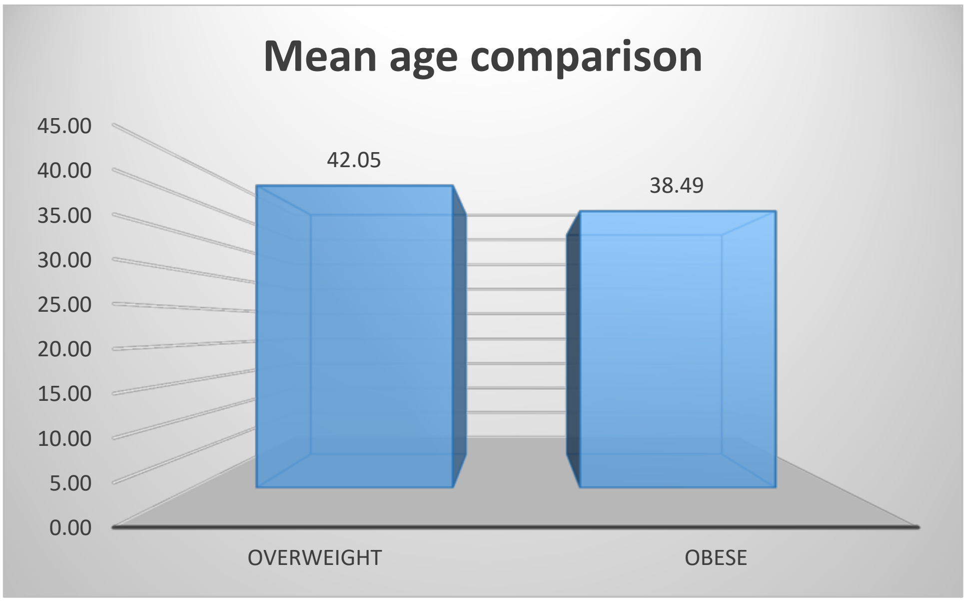



**Table 4: Distribution of study groups as per gender**

| Gender | Group | | Total |
|---|---|---|---|
| | **Overweight** | **Obese** | |
| **Female** | 24 | 20 | 44 |
| | 55.8% | 46.5% | 51.2% |
| **Male** | 19 | 23 | 42 |
| | 44.2% | 53.5% | 48.8% |
| **Total** | 43 | 43 | 86 |
| | 100.0% | 100.0% | 100.0% |
| **p- value - 0.518** | | | |

Out of the total 86 cases, 44 were females (51.2%) and 42 were males (48.8%); with no difference between study groups (p-0.518).

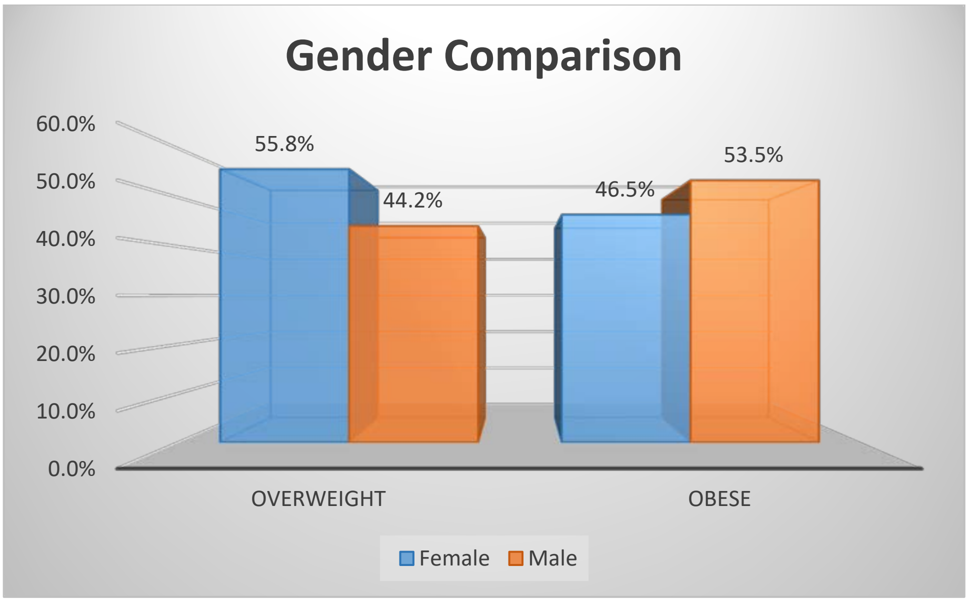



**Table 5: Distribution of study groups as per incidence of difficult airway**

| Hans Grade | Group | | Total |
|---|---|---|---|
| | Overweight | Obese | |
| **1** | 40 | 0 | 40 |
| | 93.0% | 0.0% | 46.5% |
| **2** | 3 | 36 | 39 |
| | 7.0% | 83.7% | 45.3% |
| **3** | 0 | 7 | 7 |
| | 0.0% | 16.3% | 8.1% |
| **Total** | 43 | 43 | 86 |
| | 100.0% | 100.0% | 100.0% |
| **p- value <0.01** | | | |

Incidence of difficult airway was observed in 16.3% obese cases as compared to none in overweight individuals.

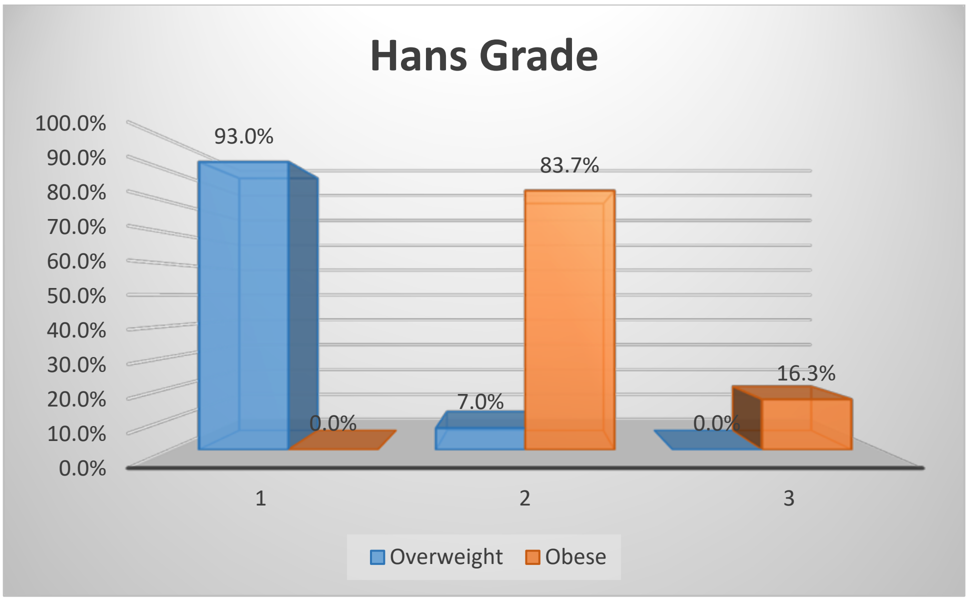



**Table 6: Mean age comparison of cases with and without difficult airway**

| Variables | Difficult Airway | N | Mean | SD | p- value |
|---|---|---|---|---|---|
| Age (yrs.) | No | 36 | 37.86 | 14.24 | 0.51 |
| | Yes | 7 | 41.71 | 12.79 | |

Mean age of the obese individuals with difficult airway was 41.71 years while that without difficult airway was 37.86 years (p-0.51).

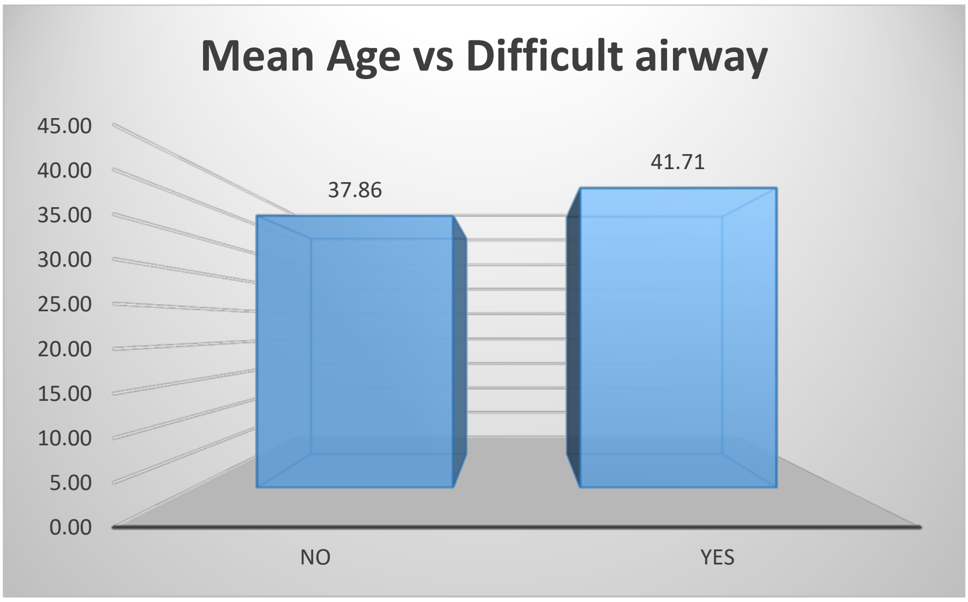



**Table 7: Association of difficult airway with age of patients**

| Age Group | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| <=30 yrs. | 14 | 2 | 16 |
| | 87.5% | 12.5% | 100.0% |
| 31-40 yrs. | 5 | 1 | 6 |

| | | | |
|---|---|---|---|
| | 83.3% | 16.7% | 100.0% |
| **41-50 yrs.** | 9 | 2 | 11 |
| | 81.8% | 18.2% | 100.0% |
| **51-60 yrs.** | 8 | 2 | 10 |
| | 80.0% | 20.0% | 100.0% |
| **Total** | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| **p- value - 0.96** | | | |

No association was observed between age and incidence of difficult airway among obese individuals (p-0.96).

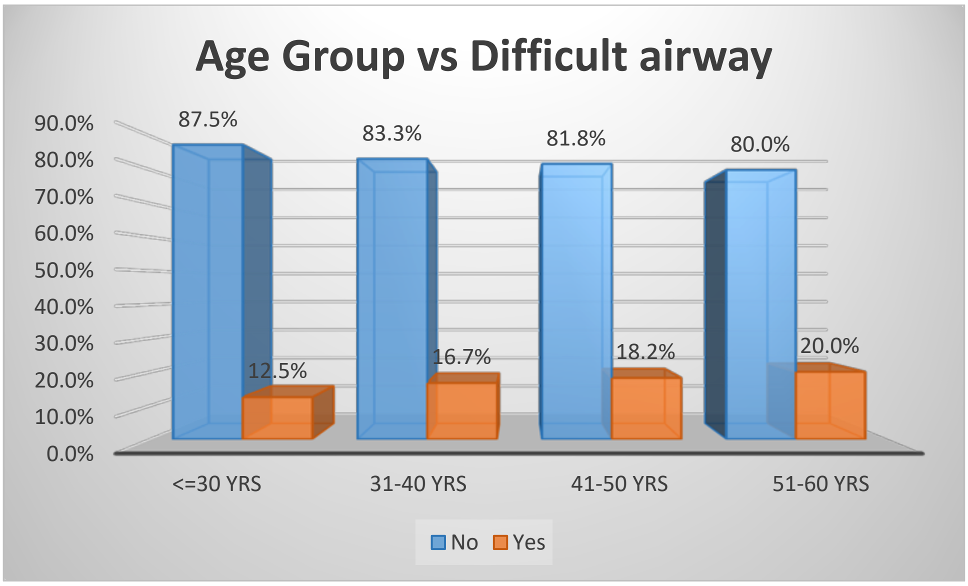



**Table 8: Association of difficult airway with gender of patients**

| Gender | Difficult Airway | | Total |
|---|---|---|---|
| | **No** | **Yes** | |
| **Female** | 17 | 3 | 20 |
| | 85.0% | 15.0% | 100.0% |
| **Male** | 19 | 4 | 23 |
| | 82.6% | 17.4% | 100.0% |
| **Total** | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| **p- value - 1.0** | | | |

No association was observed between any specific gender and incidence of difficult airway among obese individuals (p-0.86).

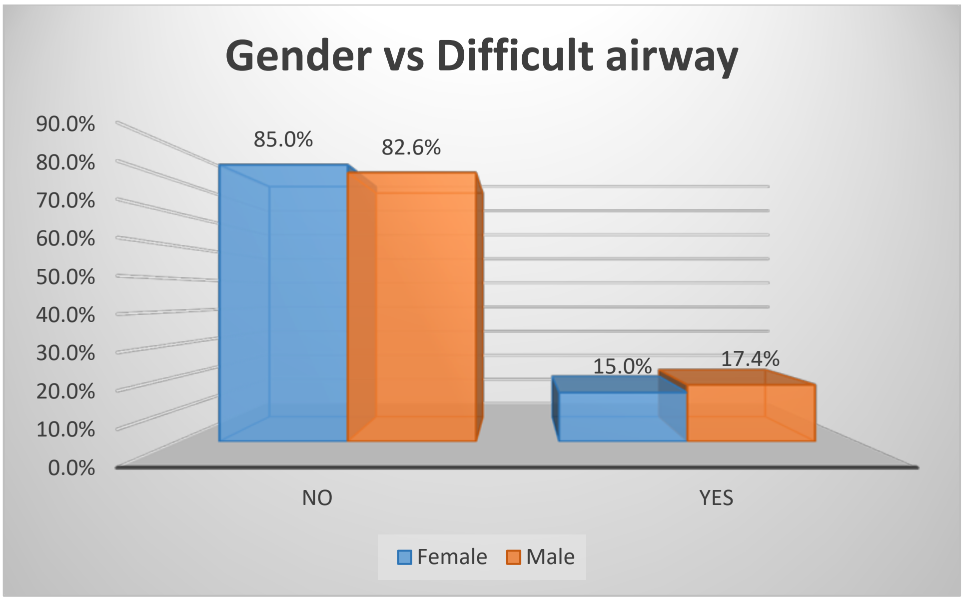



**Table 9: Mean BMI comparison of cases with and without difficult airway**

| Variables | Difficult Airway | N | Mean | SD | p- value |
|---|---|---|---|---|---|
| **BMI** | **No** | 36 | 26.60 | 1.25 | **<0.01** |
| | **Yes** | 7 | 29.12 | 2.56 | |

Mean BMI was significantly higher among cases with incidence of difficult airway (29.12 vs 26.6 $Kg/m^2$; p<0.01).

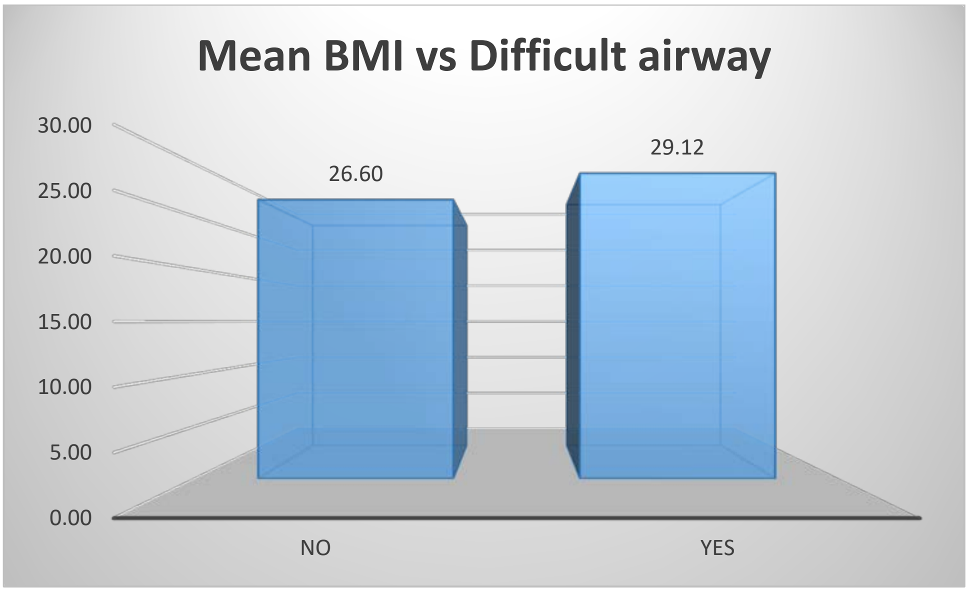



**Table 10: Mean neck circumference comparison of cases with and without difficult airway**

| Variables | Difficult Airway | N | Mean | SD | p- value |
|---|---|---|---|---|---|
| **Neck Circumference** | **No** | 36 | 37.24 | 1.75 | **<0.01** |
| | **Yes** | 7 | 40.77 | 3.59 | |

Mean neck circumference was significantly higher among cases with incidence of difficult airway (40.77 vs 37.24 cm; p<0.01).

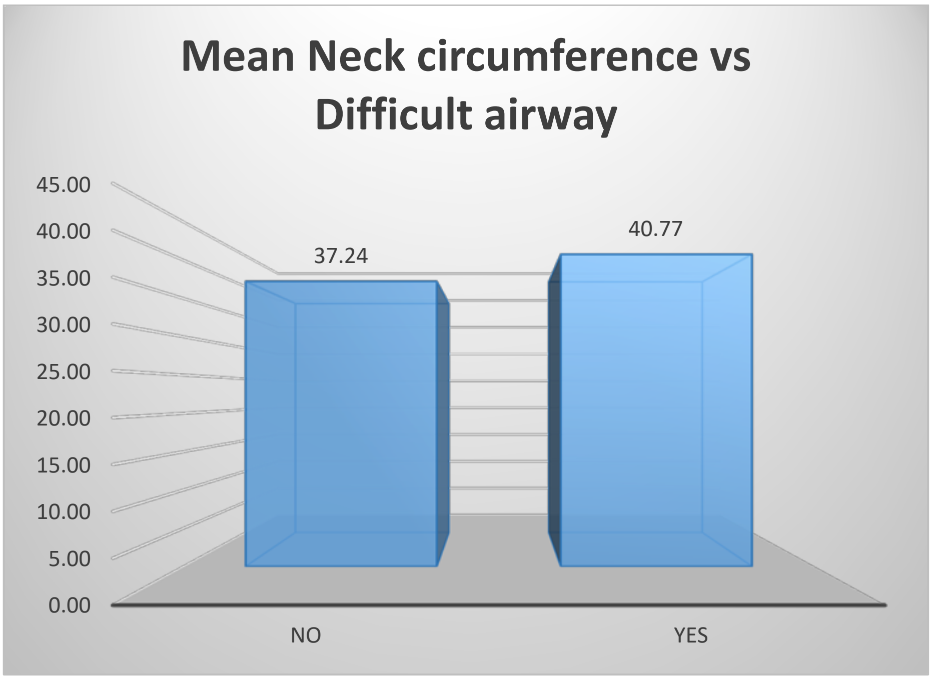



**Table 11: Association of difficult airway with ASA grade**

| ASA Grade | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| I | 23 | 3 | 26 |
| | 88.5% | 11.5% | 100.0% |
| II | 7 | 4 | 11 |
| | 63.6% | 36.4% | 100.0% |
| III | 6 | 0 | 6 |
| | 100.0% | 0.0% | 100.0% |
| Total | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| p- value - 0.09 | | | |

No association was observed between ASA grade and incidence of difficult airway among obese individuals (p-0.09).

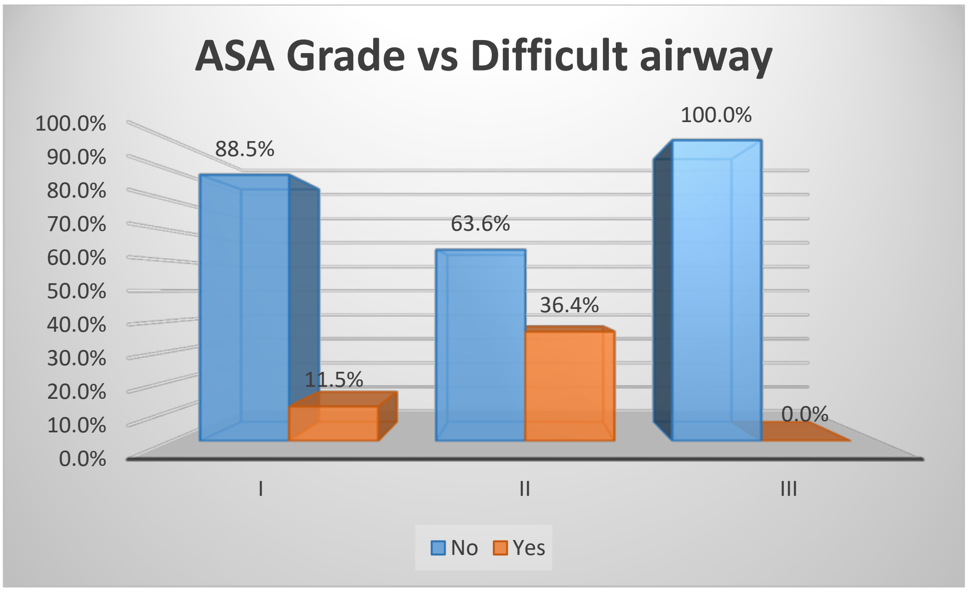



**Table 12: Association of difficult airway with mallampatti grade**

| Mallampatti Grade | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| **1** | 10 | 0 | 10 |
| | 100.0% | 0.0% | 100.0% |
| **2** | 10 | 0 | 10 |
| | 100.0% | 0.0% | 100.0% |
| **3** | 11 | 6 | 17 |
| | 64.7% | 35.3% | 100.0% |
| **4** | 5 | 1 | 6 |
| | 83.3% | 16.7% | 100.0% |
| **Total** | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| **p- value - 0.038** | | | |

Obstruction in airway as observed with mallampatti score of 3 and above was significantly associated with difficult airway in obese individuals. Difficult airway was seen in 30.43% cases with mallampatti score of 3 or more as compared to none in cases with score of less than 3 ($p<0.01$).

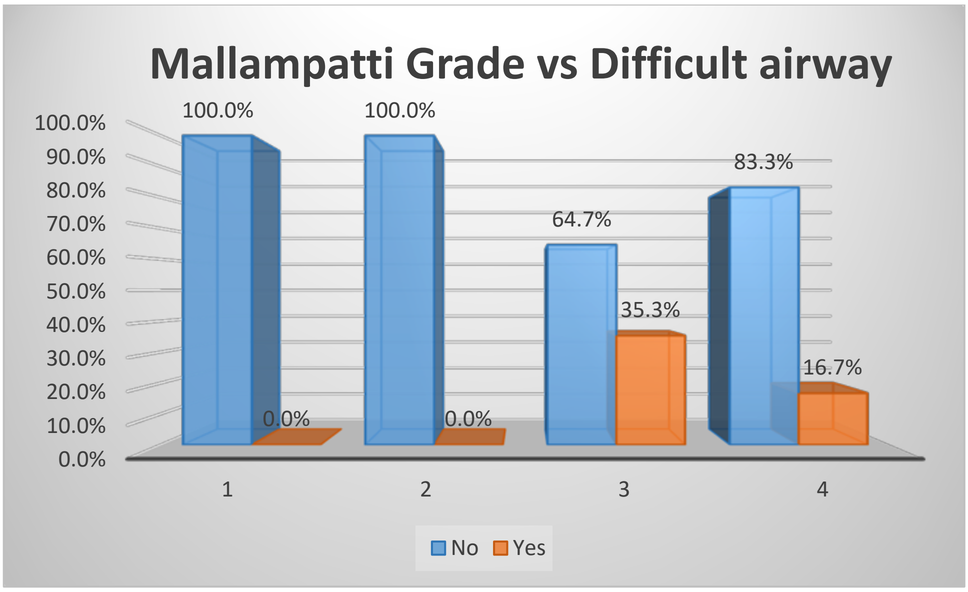



**Table 13: Association of difficult airway with presence of missing teeth**

| Missing Teeth | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| **No** | 33 | 7 | 40 |
| | 82.5% | 17.5% | 100.0% |
| **Yes** | 3 | 0 | 3 |
| | 100.0% | 0.0% | 100.0% |
| **Total** | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| **p- value - 1.0** | | | |

No association was observed between presence of missing teeth and incidence of difficult airway among obese individuals (p- 1.0).

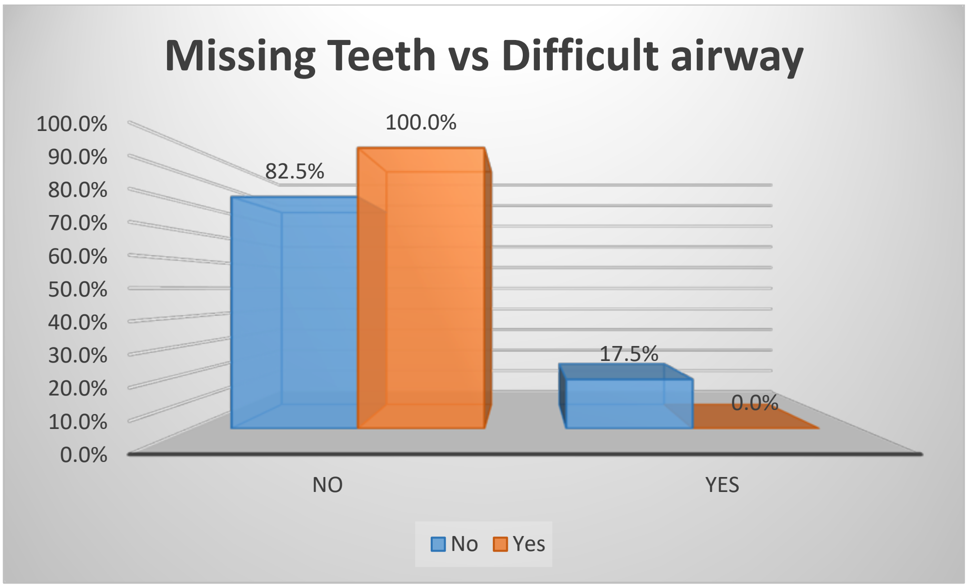


**Table 14: Association of difficult airway with thyro-mental distance**

| TMD | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| <6.5 | 20 | 5 | 25 |
| | 80.0% | 20.0% | 100.0% |
| >=6.5 | 16 | 2 | 18 |
| | 88.9% | 11.1% | 100.0% |
| Total | 36 | 7 | 43 |
| | 83.7% | 16.3% | 100.0% |
| p- value - 0.67 | | | |

No association was observed between thyro-mental distance and incidence of difficult airway among obese individuals (p-0.67).

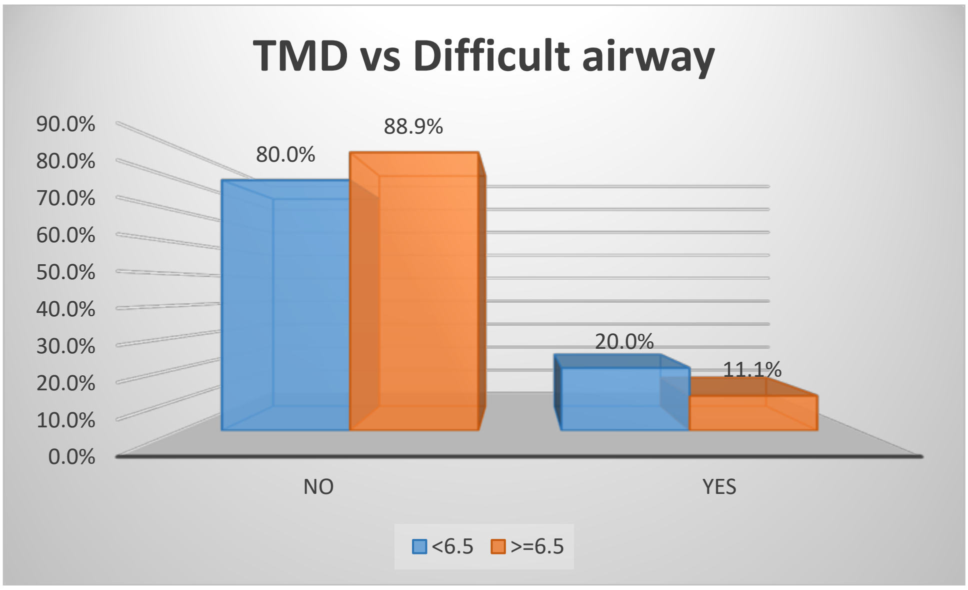
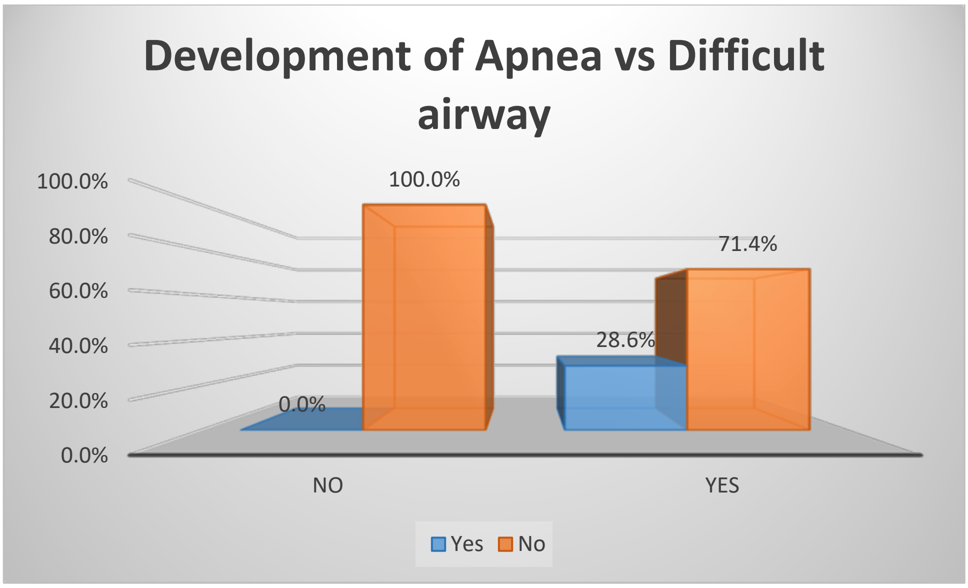



**Table 15: Association of difficult airway with development of apnea**

| Development of Apnea | Difficult Airway | | Total |
|---|---|---|---|
| | No | Yes | |
| Yes | 0 | 2 | 2 |
| | 0.0% | 28.6% | 4.7% |
| No | 36 | 5 | 41 |
| | 100.0% | 71.4% | 95.3% |
| Total | 36 | 7 | 43 |
| | 100.0% | 100.0% | 100.0% |
| p- value - 0.023 | | | |

Apnea was developed in 2 out of 7 cases (28.6%) with difficult airway as compared to none in cases without difficult airway (p-0.023).




**Discussion:**

Difficult mask ventilation (DMV) is defined as a situation where it is not possible for the unassisted anesthesiologist to maintain the oxygen saturation > 90% using 100% oxygen and positive pressure ventilation, or to prevent or reverse signs of inadequate ventilation, because of one or more of the following problems: inadequate mask seal, excessive gas lead or excessive resistance to the ingress or egress of gas. In the face of DMV, critical hypoxemia may rapidly ensue and emphasizes the need for proper identification of risk factors during the preoperative assessment [5].

Difficult airway management of the obese patient is one of the most important challenges of anesthesiologists. Obesity has also some significant changes in lung mechanics, lung volumes spirometry, respiratory muscles, breathing, and ventilation/perfusion, diffusing capacity and gas exchange. All the aforementioned changes can make airway management of obese patient too much difficult.

**Predictors of Difficult mask ventilation**

Mean BMI and neck circumference (NC) was significantly higher among cases with incidence of difficult airway (29.12 vs 26.6 Kg/m$^2$; $p<0.01$ and 40.77 vs 37.24 cm; $p<0.01$). We also observed that obstruction in airway i.e. mallampatti score of 3 and above was significantly associated with difficult airway in obese individuals. Difficult airway was seen in 30.43% cases with mallampatti score of 3 or more as compared to none in cases with score of less than 3 ($p<0.01$). No association was observed with age, gender, ASA grade, deficiency of teeth and thyromental distance.

Cattano D et al. [4] in their study observed three idependent predictive factors for DMV in obese patients were identified: age 49 years, short neck, and neck circumference >43 cm. Brodsky et al. showed that Mallampati score of 3 and increasing neck circumference at the thyroid cartilage was related with difficult airway. With a neck circumference of 40 cm and 60 cm, the probability of a difficult airway was about 5% and 35%, respectively [88]. In the prospective study, Langeron et al. [20] recognized preoperative predictors of difficult mask ventilation as: age >55 years, BMI >26 kg/m2 and deficiency of teeth. If at least two of these features were found, the likelihood of difficult mask ventilation increased notably. Kheterpal et al. [22] stated that age more than 57 years, BMI more than 30 kg/$m^2$, Mallampati class III or IV, and limited jaw protrusion are independently related with difficult mask ventilation. The multivariate analysis by Leoni A et al. [15] observed NC (OR 1.17; P<0.0001) and Mallampati test (OR 2.12; P=0.009) as risk predictors for DMV. Moon TS et al. [26] in their study also observed that morbidly obese patients were more likely to have difficult mask ventilation (OR = 3.785, 95% CI: 3.2- 4.5; p < 0.01). Other factors associated with difficult mask ventilation included patient age > 46 years, male sex, Mallampati 3–4, and a history of obstructive sleep apnea.

## Complications:

In present study, we observed that apnea developed in 2 out of 7 cases (28.6%) with difficult airway. In the study by De Jong A et al. [25], life threatening complications were observed in 41% obese cases with difficult mask airway.

## Conclusion:

Difficult mask ventilation is a significant problem among obese individuals, seen in every one out of six individuals during induction of general anaesthesia. Difficult mask ventilation among the overweight population was significantly less as compared to obese.

Difficult mask ventilation was significantly associated with increasing obesity as seen with its positive correlation with BMI and neck circumference. Obstruction in airway as observed with mallampatti score of 3 and above also significantly correlates with difficult airway in this case.

All these factors should be kept in mind during induction of general anaesthesia in obese individuals as difficult airway may cause failure in establishing ventilation, as seen in one third of our cases, which leads to serious consequences like apnea which may subsequently leads to brain damage. Further studies with larger sample size to be conducted to substantiate our findings further.

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