The supraglottic airway device as first line of management in anticipated difficult mask ventilation in the morbidly obese

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Abstract

Background and Aims: Supraglottic airway devices (SGAs) are used to rescue difficult and failed mask ventilation (DMV). We aimed to use the SGA as first-line device, prior to obtaining a definitive airway and to find any predictors of difficulty for the same, in the morbidly obese patients.

Material and Methods: Obese surgical patients [body mass index (BMI) >35 kg/m^2] were investigated. Difficulties with bag mask ventilation (MV) was graded using the following scale: MV-1, one anesthesiologist unassisted could achieve MV and maintain SpO_2 >90%; MV-2, one additional anesthesiologist was needed to facilitate MV to achieve SpO_2 > 90%; MV-3, two additional anesthesiologists were needed for this purpose; and MV-3P, when a supraglottic device was required to ventilate and maintain SpO_2 more than 90%. Parameters studied were age, gender, neck circumference (NC), BMI, STOPBANG score, and safe apnea time (SAT).

Results: Logistic regression was performed for predictors of MV-3P; receiver operating characteristic curve was used to locate the best cut-off. Analysis of 834 morbidly obese patients revealed an incidence of MV 1/2/3/3-P as 16%/38%/27%/19%, respectively. DMV was associated with BMI ≥50 kg/m^2, NC ≥49.5 cm, and STOPBANG ≥6; $P < 0.001$. The mean SAT for a population with mean BMI 48 ± 8 kg/m^2 was 256 ± 66 s. The SAT showed inverse relation to BMI and NC. As per our results, the NC was the single most important predictor of MV-3P, with sensitivity 0.62 and specificity 0.85 at best cut-off 49.5 cm; $P < 0.001$.

Conclusion: NC ≥49.5 cm is strongly associated with low SAT and need for SGA to achieve MV. SGA may provide safety for initial management following induction of anesthesia in this patient population.

Keywords: Apnea time, body mass index, bariatric, difficult airway, mask ventilation, neck circumference, obese, STOPBANG

Introduction

The American Society of Anesthesiologists (ASA) recognized difficult mask ventilation (DMV) 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. Studies have graded MV based on the number of providers required to aid ventilation.

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Anesthesiologists handling these patients are frequently endangered with facing a DMV, in an oxygen-deprived environment where a patient with low oxygen reserves faces airway obstruction due to easy airway collapsibility.

The recent guidelines [All India Difficult Airway Association (AIDAA), Difficult Airway Society (DAS) re-emphasize the importance of continuous oxygenation while managing the airway. The airway challenges in the obese are not just anatomical but also physiological.[1-4] In

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the morbidly obese, hypoxemia sets in within shorter time following the onset of apnea.[1,5] This could be during assisted ventilation or oxygenation or resulting from high flow of oxygen for apneic oxygenation in absence of ventilation.[1-3]

Prior recommendations have focused on optimizing oxygenation for success of bag MV prior to laryngoscopy attempts for endotracheal intubation.[4,5] We investigated whether use of supraglottic airway devices (SGAs) in place of conventional bag MV would provide improved oxygenation and that the SGAs can be used as first line of management while anesthetizing the morbidly obese.[6] Our primary objective was to determine the feasibility of using the SGAs as first-line device prior to definitive airway and to find any predictors for their requirement in the morbidly obese patients. Our secondary objective was to evaluate the safe apnea time (SAT) and analyze its variation with other demographic features.

Material and Methods

With the approval of the Institutional Review Board and written informed consent from the patients, we retrospectively analyzed the outcome data from 834 consecutive adult patients of either gender and body mass index (BMI) >35 kg/m^2 who underwent laparoscopic bariatric surgery at our center between 2013 and 2015. Written informed consent was obtained from all subjects or their legal surrogate. The study was approved and registered after collection of data. The preanesthetic check up comprised filling up of an airway assessment form which included information on age, gender, BMI, neck circumference (NC) (cm) measured at the level of the thyroid cartilage and Mallampati grade, any obvious indication of difficulty in MV (mandibular protrusion, beard, missing teeth, etc.), STOPBANG score, history of difficult intubation, and cervical spine injury.

Patients with documented history of gatroesophageal reflux disease, pregnancy, any severe cardiac or severe pulmonary disease, cervical spine injury, and any obvious indication of difficulty in MV (mandibular protrusion, beard, missing teeth, etc.) or missing documentation of DMV or difficult intubation were excluded from the study.

The airway assessment protocol was standardized. Based on clinical suggestions and previously published results, the preoperative parameters were identified as age, gender, NC, BMI, and STOPBANG score.[7,8] Information on the preoperative parameters that were identified during preoperative assessment was obtained from the chart filled by the anesthesiologist at the time of initial interaction and during induction of anesthesia. All airway management was executed on the ramp (rapid airway management position or the head elevated laryngoscopy position) on the operation theater table. Scale-ampule assembly was used to keep the tragus and manubrium sterni in line.[9] Airway management was as per Figure 1, and the same clinical team of three anesthesiologists, experienced in taking care of the obese for 20 years, provided the care to all patients. Anesthesia was induced with propofol, fentanyl [based on ideal body weight (IBW)], and sevoflurane 1%–2% in oxygen. Atracurium 0.5 mg/kg (IBW) was used to facilitate MV.

The degree of MV was graded as MV-1 when one anesthesiologist could mask ventilate unassisted, MV-2 when two anesthesiologists were required, as MV-3 when three anesthesiologists were needed, and as MV-3P when despite this assistance the patient could not be ventilated and a supraglottic device (ProSeal laryngeal mask airway) was needed to be inserted to achieve ventilation and to maintain SpO_2 greater than 90%. Grade MV-3P was considered DMV.[10,11] Failure to achieve MV was also recorded and plan was to follow DAS protocol in case of failure mask ventilate. Following device placement, the SAT was calculated as the time from onset of apnea to time to achieve SpO_2 90%. General anesthesia monitoring was performed as per ASA standard. The same were documented in patient's anesthesia records.

Statistical analysis

The mean and standard deviation (SD) of various quantitative measurements were calculated for each category of MV. The statistical significance of the difference in their means was assessed by one-way analysis of variance (ANOVA) followed by Tukey's test to locate the DMV group that had significant pairwise differences. Box-plots were also obtained to get a visual view of the changes across DMV categories. Cross-tabulations and Chi-square test were done for qualitative variables such as gender. The SAT was considered to depend on NC and BMI, and the relationship was obtained by simple linear regression to obtain preoperative factors that can predict this. Since our target was MV-3P, a logistic regression of MV-3P versus others was obtained to identify factors that can predict MV-3P. A P value less than 0.05 was considered statistically significant.

Receiver operating characteristic (ROC) curve was used to locate the best cut-off of the significant predictor of DMV for obese patients (MV-3P). Statistical analyses were performed using SPSS version 20. Values were reported as mean ± SD

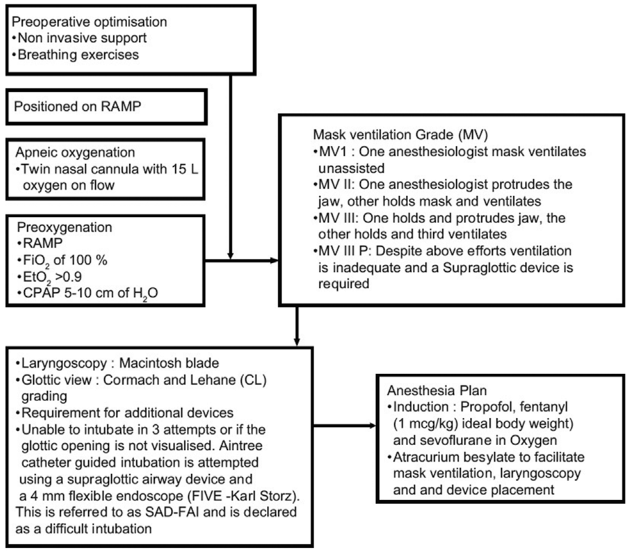

Figure 1: Airway management plan followed for the obese patients

for continuous variables and frequency (percentage) for categorical variables for all preoperative patient characteristics. In a previous study, the incidence of DMV was 14.3%. To estimate this within 3% with 95% confidence, the sample size required is 524. We included all patients conducted within the stipulated period.

Results

A total of 834 patients were analyzed for MV characteristics and SAT. Patient demographics and their characteristics are as per Tables 1 and 2. On plotting the ROC for NC, the best cut-off was found to be ≥49.5 cm, with a sensitivity of 62.4% and specificity of 84.5%.

The number of patients with various levels of difficulty with MV was MV I/II/III/III-P: 16%/38%/27%/19%. All the assessed factors were significantly different in various MV categories except age ($P < 0.001$) by ANOVA [Table 3]. MV grade was strongly associated with BMI ≥50 kg/m^2, NC ≥49.5 cm, and STOPBANG ≥6 [Table 3]; $P < 0.001$, which is statistically significant.

Among all the factors assessed, the MV grade was found to be affected most by the NC (anatomical factor) and the SAT among the functional factors [Table 3].

MV difficulty (both MV and MV-3P) showed direct relation with NC and STOPBANG; $P < 0.001$ [Figures 2 and 3]. This means that difficulty in MV requiring a supraglottic device is largely determined by NC and STOPBANG score.

However, using multiple comparisons (Tukey's HSD), the NC was found to significantly differ between each pair of MV ($P < 0.001$) [Figure 2]. Though the MV grade varied with different BMI, the relation or statistical significance between the BMI and MV category was inconsistent [Figure 4].

An important outcome of this study was the SAT. The mean SAT was 256 ± 66 s for a population with mean BMI 48 ± 8 kg/m^2; it showed inverse relation to BMI and NC [Figure 5]. NC and BMI were found to be closely related to SAT ($P < 0.001$). The best linear regression equation was "SAT (in seconds) =351 − 2 × NC (in cm)" can be used for prediction of the SAT, based on the NC, and the best linear regression equation is SAT = 424 − 3.5 × BMI (in kg/m^2) for prediction of SAT based on the BMI.

We further found that patients in the category MV-3P had mean NC >50 cm, mean SAT of 287 s, and mean STOPBANG of 6; values rounded off to the first decimal place. The incidence of obstructive *sleep apnea* (OSA) as judged using STOPBANG score was 95% (moderate 43%; severe 52%) in our study. There were 52% patients with STOPBANG ≥6 (severe OSA), which implies presence of severe OSA. The success rate of SGD insertion in our patients was 100%.

The SAT in the MV grades I (easiest MV) and 3-P (most difficult) are comparable and significantly higher than that in MV-2 and MV-3. This suggests that use of supraglottic device to achieve ventilation in MV-3 *P* could sufficiently increase the SAT to the level in patients with MV-1 and can be suggested as the preferred choice to achieve MV in obese patients with large neck, high BMI, and high STOPBANG score. Furthermore, the SAT was significantly higher in the MV-3P group [Figure 6].

Logistic regression of the patient characteristics [Table 4] revealed that NC is the only anatomical factor independently associated with difficulty in MV with odds ratio [1.25 (confidence interval 1.18–1.31), $P < 0.001$]. At the same time, the SAT is the physiological factor determining difficulty in MV with odds ratio [1.019 (confidence interval 1.014–1.019), $P < 0.001$]. Trends in the MV categories are better depicted in Figures 2-6.

Discussion

Airway management in the obese is centered around optimizing oxygen reserves and preventing hypoxemia. We evaluated the MV in the morbidly obese in view of their limited SAT and

Table 1 : Patient Characteristics

	Mean	Standard Deviation
Age (years)	41	12
BMI (kg/m²)	48	7
STOPBANG	5	2
SAT (seconds)	256	66
Recovery Time (seconds)	44	5
Min SpO_2%	77	8
NC (cm)	45	6

Values are rounded off upto first decimal place. SAT is safe apnea time; NC is neck circumference

Table 2: General characteristics

		Count (834)	*n* %
Surgery	Bypass	628	75%
	Sleeve Gastrectomy	183	22%
	Others	23	3%
M/F		378/456	45/55%
MV grade	1	133	16%
	2	320	38.4%
	3	224	26.8%
	3P	157	18.8%
STOPBANG	0-2	38	4.6%
	3-5	364	43.6%
	6-8	432	51.8%

M/F is male/female; MV is mask ventilation

Table 3: Patient distribution as per mask ventilation grade

MV grade	Num	Age years	BMI (kg/m²)	NC (cm)	STOPBANG	SAT (sec)
1	133	40	43	38	3.9	276
2	320	41	49	44	5.2	248
3	224	41	48	48	5.7	234
3-P	157	40	50	50	5.9	287
P		NS	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001

Values are expressed as Mean; MV is mask ventilation; BMI is body mass index; NC is neck circumference; SAT is safe apnea time ; and RT is recovery time; NS is not significant

focused on the feasibility of using a supraglottic device as first line of management for achieving MV prior to inserting the definitive airway.[4,12]

In view of high prevalence of DMV and low SAT in the obese, it is imperative to build up the oxygen reserves and identify and optimize the risk factors preoperatively. Higher incidence of DMV has been found in the obese population. Previous reports suggest an incidence of 14%; however, in this study cohort it was 19% with respect to requirement for supraglottic device. However, considering MV-IIIP and MV-III together, the incidence was as high as 45%.[13-15]

Unlike some previous reports, our results did not find any suggestions of influence of age on the difficulty in MV.[16-19]

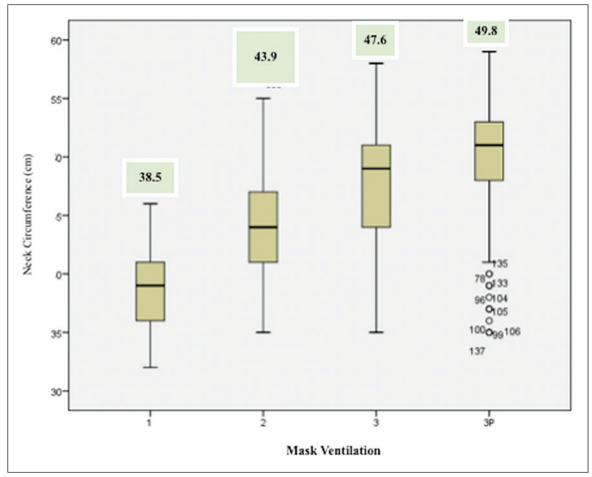

Figure 2: NC: Neck circumference, MV: mask ventilation Difficulty in mask ventilation is directly related to neck circumference and NC is significantly different between each pair of groups of MV. The figure at the top of the box reflects mean NC in centimetres

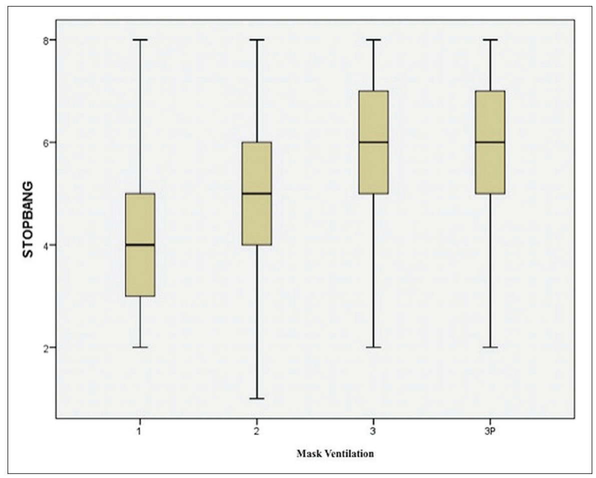

Figure 3: Difficulty in mask ventilation is directly related to STOPBANG score

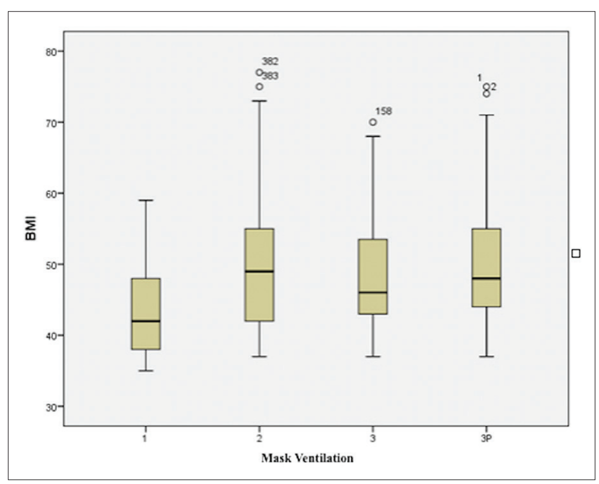

Figure 4: The relation between BMI and difficulty in mask ventilation was found to be inconsistent. BMI: body mass index

We excluded the previously established indicators of DMV from our analysis, as we wanted to assess obesity-related parameters,

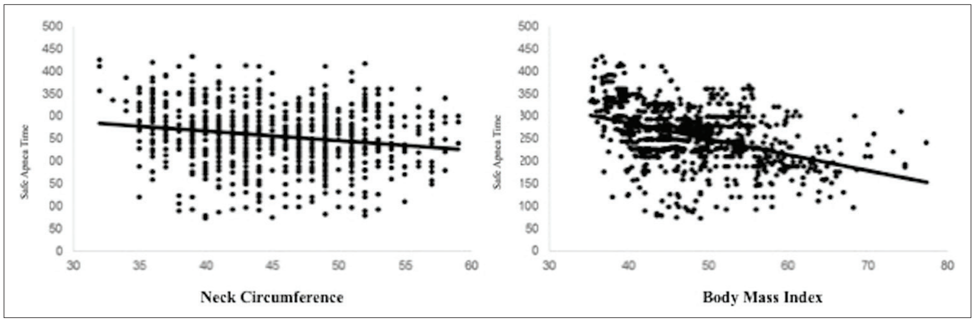

Figure 5: This depicts the relation between safe apnea time (SAT) and neck circumference (NC) and body mass index (BMI). SAT is inversely related to both

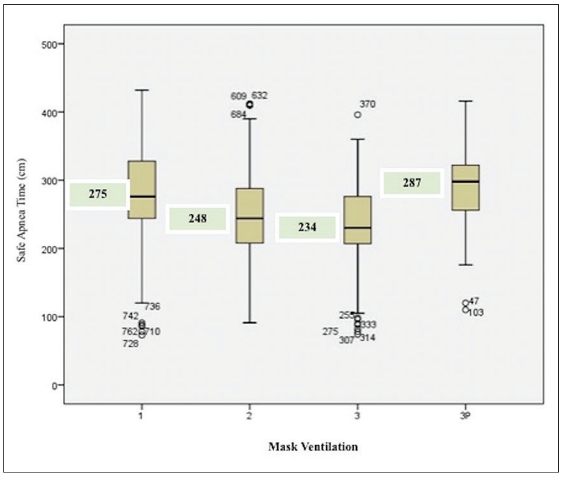

Figure 6: The safe apnea time (SAT) in seconds in mask ventilation grade 1 (M-1) is comparable to that in MV-3P; whereas it is significantly higher that SAT in MV-2 and MV-3

Table 4: Logistic regression of all patient related factors with respect to patients with MV requiring supra glottic device (MV-3P)

	P	OR	95% C.I. for OR	
			Lower	Upper
Age (years)	NS	0.988	0.970	1.005
Gender	NS	0.910	0.692	1.716
BMI (kg/m²)	NS	1.026	0.982	1.065
Waist Circumference (cm)	NS	0.997	0.978	1.014
NC (cm)	<0.001	1.247	1.18	1.31
STOPBANG	NS	1.158	0.973	1.407
SAT (seconds)	<0.001	1.019	1.014	1.023

NS is not significant (P>0.01); SAT is safe apnea time; NC is neck circumference. Only neck circumference (NC) and safe apnea time (SAT) are statistically significant for predicting mask ventilation grade-3-P (MV-3P)

some of which have not been previously analyzed.[19,20] Moreover, we wanted to assess the selected factors in relation to limited SAT in the morbidly obese patients.

Literature mentions OSA as one factor responsible for impossible MV.[9] The rising prevalence of OSA in obese population has possibly contributed to the rising incidence of DMV, and the poor oxygen reserves compounds the deleterious effects of DMV.[21,22] Given the higher incidence of airway-related adverse events in sleep apneics, it is extremely important to identify patients suffering from OSA preoperatively.[23-26] We relied on the clinical scoring STOPBANG to screen for OSA, and the same has been shown to have a close correlation with sleep study.[21-26]

The obese airway poses challenges that are both anatomical and physiological. Our results suggest that the requirement for the SGD is maximum for patients with difficulty in MV. In patients where SGD was used to aid to MV, it could provide effective PEEP and further prolong the SAT. SGD can be suggested as the first line of management for MV in patients with these specifications as in these patients the MV is further limited by low SAT. Hence, the use of SGD can be adopted as an alternative to conventional MV in obese patients.[8,11] One limitation of our study was that we did not calculate the time of SGD insertion.

Higher NC is reflective of presence of pharyngeal adipose tissue, which further compounds the airway collapse that ensues at onset of induction of anesthesia and sedation. As per our results, the NC was found to be the most significant determinant of difficulty in MV and hence of the requirement for supraglottic device.

Our results imply that higher BMI patients and those with higher NC will have much lesser SAT and will require greater attention to preoperative optimization of oxygen reserves. The supraglottic device will be particularly helpful in not just as an aid to ease out MV, provide PEEP that will recruit more alveoli, decompress the stomach, and minimize operator fatigue but also can be used to facilitate endotracheal intubation using Aintree catheter.[27-29]

Conclusion

In this study we demonstrated that BMI, NC, STOPBANG, and SAT have statistically significant relation with MV. Furthermore, NC and SAT have strong predictive value for DMV. This demands focus on optimization of oxygen reserves in these patients and availability of supraglottic device as the preferred choice for achieving MV when neck is ≥49.5 cm. Thus, we suggest that these patient-dependent factors should be included in routine preoperative assessment as screening tools to better predict and optimize DMV in the obese patients.

Compliance with ethical standards

This study was conducted in compliance with Good Clinical Practice (GCP) and in accordance with the ethical principles that have their origin in the Declaration of Helsinki.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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