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COMPARISON OF FACE MASK TO NASAL MASK VENTILATION IN OBESE SUBJECTS UNDERGOING GENERAL ANESTHESIA

Dr. Sandhya Kashyap Kawachi,[1] Dr. Nikhil Ashok Patil[2]*

[1]Assistant Professor, Department Of Anesthesiology, Gouri Devi Institute of Medical Sciences & Hospital, Durgapur, West Bengal

[2*]Assistant Professor, Department of Anesthesiology, ICARE Institute of Medical Sciences and Research, Haldia, West Bengal

Corresponding Author

Dr. Nikhil Ashok Patil
Email Id- nikhil.patiln@gmail.com

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ABSTRACT

Background: During the induction of general anesthesia, the use of a face mask is usually ineffective in providing adequate ventilation in obese subjects. However, ventilation via nasal mask is shown to be effective in providing CPAP (continuous positive airway pressure) in obese subjects having OSA (Obstructive sleep apnea). Existing literature data is scarce concerning this comparison.

Aim: The present study aimed to comparatively assess the efficacy of face mask to nasal mask ventilation in obese subjects undergoing general anesthesia and having BMI (body mass index) >25 kg/m2.

Methods: The study assessed 180 subjects having BMI >25 kg/m2 that were randomly divided into two groups of 90 subjects each where Group I subjects received ventilation via face mask and Group II subjects via nasal mask during general anesthesia induction. In both the groups, EtCO2 (end-tidal carbon dioxide), SpO2 (oxygen saturation), PPLAT (plateau pressure), PIP (peak inspiratory pressure), and VtE (expired tidal volume) were assessed for 10 breaths and the mean values were recorded and compared.

Results: The study results showed that mean values of expired tidal volume were 455.96±55.62 and 436.88±49.48 mL for nasal mask and face mask ventilation groups depicting a non-significant difference with p=0.07. Mean PPLAT, mean PIP, and mean air-leak were significantly lower in the nasal mask ventilation group compared to the face mask ventilation with respective p-values of

0.001, 0.001, and 0.001. Hemodynamic measurements, SpO2, and EtCO2 levels were comparable between the two groups.

Conclusions: The present study concludes that nasal mask ventilation has higher efficacy compared to face mask ventilation and can be used as an alternative to face mask ventilation in obese subjects with BMI >25 kg/m2 under general anesthesia.

Keywords: Body mass index, face mask, nasal mask, obesity, ventilation

INTRODUCTION

In the initial stages of the induction of general anesthesia, a vital role is played in mask ventilation which serves as the main way of ventilating the subject before a definitive airway is secured.[1] Mask ventilation covers two vital aspects including the maintenance of an unobstructed upper airway and ensuring the airtight seal between the face of the subject and the mask which helps prevent the leakage of the gas.[2] In subjects having BMI (body mass index) of more than 25 kg/m2 often present various anatomical changes in the airways that mainly affect the larynx and oropharynx. CPAP or continuous positive airway pressure given using the nasal mask helps in the prevention of upper airway collapse which is a highly effective management strategy for OSA (obstructive sleep apnea).[3,4]

This mechanism shares similarities with the upper airway where the obstruction is usually seen during the induction of the general anesthesia.[5] Ventilation using the nasal mask directs the inspired air through the nasal cavity that counters the influence of gravity on the tongue and soft palate, which, in turn, helps in maintaining the patency of the upper airway. This is followed by direct nasal ventilation which may help in improving the efficacy of ventilation and result in natural breathing patterns.[6,7]

The present study has a hypothesis that nasal mask ventilation has superior efficacy compared to conventional face mask ventilation in obese subjects under general anesthesia by ensuring lesser airway obstruction and better mask seal. Hence, the present study aimed to comparatively assess the efficacy of face mask to nasal mask ventilation in obese subjects undergoing general anesthesia and having BMI (body mass index) >25 kg/m2.

MATERIALS AND METHODS

The present randomized clinical study was aimed to comparatively assess the efficacy of face mask to nasal mask ventilation in obese subjects undergoing general anesthesia and having BMI (body mass index) >25 kg/m2. The study was done after the clearance was given by the concerned institutional Ethical committee. The study subjects were those placed for surgery under general anesthesia. Verbal and written informed consent were taken from all the subjects before study participation.

The study included 180 subjects who were undergoing surgery at the Institute under general anesthesia, were obese, and had a BMI of >25 kg/m2, aged 18 years or more, and subjects under ASA (American Society of Anesthesiologists) status I, II, or III. The exclusion criteria for the study were subjects having contraindication to any study drug, pregnant females, retrognathia, prognathia, and beard, subjects having a history of maxillofacial trauma, and subjects that did not give informed consent for study participation.

In all the subjects, a comprehensive pre-anesthetic evaluation was done including the recording of detailed history, physical examination, and laboratory investigations. The subjects that met the inclusion criteria were randomly divided into two groups having 90 subjects each where Group I subjects were given face mask ventilation and Group II subjects were given nasal mask ventilation.

In study subjects, standard monitoring was done in the operating room comprising of capnography, SpO2 (oxygen saturation), non-invasive blood pressure measurement, heart rate, and electrocardiography. The head of the study subjects was placed in a neutral position on a pillow with an elevation of 10 cm from the operating table. Pre-oxygenation was done using 100% oxygen for 3 minutes at a flow rate of 10 L/min using a face mask of appropriate size that was tightly held. This was assessed by placing the upper mask end at the bridge of the nose and the lower end below the lower border of the lower lip. This was followed by anesthesia induction using intravenous fentanyl and propofol at a dose of 1-2 mg/kg body weight where titration was done to the loss of verbal response. After verification of the ventilation ability, administration of 0.5 mg/kg besylate was done, and lung ventilation was done with an appropriate technique based on the group.

In Group I, face mask ventilation, a transparent silicone face mask was used for ventilation and the mask was placed using a hand CE grip between the lower border of the lower lip and the nasal bridge. In Group II, nasal mask ventilation, ventilation was done using a nasal mask placed using a hand CE grip between the lower border of the lower lip and the nasal bridge. The mask ventilation was performed by a trained anesthetist having experience and expertise in the field.

After anesthesia induction, a ventilator was used for ventilation that was set at VCV (volume-controlled mode) at the pre-set flow of gas at 10 L/min, pressure limit of 40 cmH2O, respiratory rate of 10 breaths/ minutes, and tidal volume of 7 mL/kg. After ventilation of 3 minutes and positive capnography tracing verification, all the parameters were recorded including EtCO2 (end-tidal carbon dioxide), PPLAT (plateau pressure), PIP (peak inspiratory pressure), air leak (difference in expired and set tidal volume), expired tidal volume (VtE), and tidal volume for 10 breaths in every subject. For all the assessed parameters, the mean value for 10 breaths was assessed. Mask ventilation adequacy was assessed and inadequate ventilation was considered in cases where capnography showed low amplitude wave with EtCO2 and no visible chest rise.

The primary outcome assessed in the subjects was mean expired tidal volume in the two study groups. The secondary outcomes assessed were mean EtCO2, mean SpO2, PPLAT, mean PIP, and mean air leak. AjBW (adjusted body weight) was evaluated as AjBW = IBW (estimated ideal body weight) + (ABW -IBW) where ABW stands for actual body weight. The ideal body weight was considered as 50 kg + 2.3 kg for each inch more than 5 feet in males and 45.5 kg + 2.3 kg for each inch more than 5 feet in females.[8]

The data gathered were analyzed statistically using the SPSS software version 21.0 (IBM Corp., Armonk, NY, USA) and the t-test with chi-square test. The data were expressed as mean and standard deviation and frequency and percentage. Statistical significance was kept at a p-value of <0.05.

RESULTS

The present randomized clinical study was aimed to comparatively assess the efficacy of face mask to nasal mask ventilation in obese subjects undergoing general anesthesia and having BMI (body mass index) >25 kg/m2. The present study included 180 subjects that were randomly divided into two groups having 90 subjects each where Group I subjects were given face mask ventilation and Group II subjects were given nasal mask ventilation. The mean age of the study subjects in the face mask and nasal mask ventilation group was 41.65±10.52 and 43.14±12.86 years respectively. There were 44.4% (n=40) males and 55.5% (n=50) females in the face mask ventilation group and 42.22% (n=38) males and 57.77% (n=52) females in the nasal mask ventilation group respectively as shown in Table 1.

On assessing the demographic data in two groups of study subjects, it was seen that the mean BMI in the face mask and nasal mask ventilation group was 29.95±2.75 and 30.38±2.38 kg/m2 respectively. The mean height was 164.14±7.09 and 164.26±6.78 cm in the face mask and nasal mask ventilation group respectively. Adjusted body weight in the face mask and nasal mask ventilation group was 66.91±7.44 kg and 67.47±7.55 kg respectively, whereas, actual body weight in the face mask and nasal mask ventilation group respectively was 80.82±9.10 and 82.20±8.85 kg. Neck circumference was 35.42±3.54 and 36.21±3.41cm in the face mask and nasal mask ventilation group respectively. There were 35.5% (n=32), 57.7% (n=52), and 6.66% (n=6) subjects respectively in ASA status I, II, and III in the face mask ventilation group and 57.77% (n=52), 17.7% (n=16), and 24.4% (n=22) subjects from ASA status I, II, and III respectively from nasal mask ventilation group. STOP-BANG scores of 0, 1, 2, 3, and 4 were seen in 31.1% (n=28), 24.4% (n=22), 28.8% (n=26), 8.88% (n=8), and 15.5% (n=6) subjects from face mask ventilation group and in 17.7% (n=16), 22.2% (n=20), 20% (n=18), 33.3% (n=30), and 15.5% (n=6) subjects respectively from nasal mask ventilation group (Table 1).

The study results showed that for the comparison of ventilation parameters in two groups of study subjects, it was seen that mean plateau pressure was significantly higher in the face mask ventilation group with 16.64±2.54 cmH2O compared to 12.02±1.19 cmH2O in nasal mask ventilation group with p=0.001. the oxygen saturation was 99.59±0.95% in the face mask ventilation group and 99.62±1.02% in the nasal mask ventilation group. The difference was statistically non-significant with p=0.44. A similar non0-significant difference was seen for end-tidal carbon dioxide levels that were 30.14±2.25 mmHg in the face mask ventilation group and 28.87±1.82 mmHg for the nasal mask ventilation group with p=0.14 as depicted in Table 2.

It was also seen that concerning the comparison of ventilation parameters in face mask ventilation and nasal mask ventilation groups, PIP (peak inspiratory pressure was significantly higher in face mask ventilation group with 19.92±3.03 cmH2O compared to 14.77±1.36 cmH2O in nasal mask ventilation group with p=0.001. The air leak was significantly higher in the face mask ventilation group with 31.61±21.54 mL compared to16.42±22.14 mL in the nasal mask ventilation group with p=0.001. Expired tidal volume was 436.88±49.48 mL in the face mask ventilation group and 455.96±55.62 mL in the nasal mask ventilation group with p=0.001. Expired tidal volume was statistically non-significant in the face mask and nasal mask ventilation group with 436.88±49.48

and 455.96±55.62 mL with p=0.07. A similar non-significant difference was seen for set tidal volume with p=0.54 as summarized in Table 2.

DISCUSSION

The present study included 180 subjects that were randomly divided into two groups having 90 subjects each where Group I subjects were given face mask ventilation and Group II subjects were given nasal mask ventilation. The mean age of the study subjects in the face mask and nasal mask ventilation group was 41.65±10.52 and 43.14±12.86 years respectively. There were 44.4% (n=40) males and 55.5% (n=50) females in the face mask ventilation group and 42.22% (n=38) males and 57.77% (n=52) females in the nasal mask ventilation group respectively. These data were similar to the studies of Kapoor MC et al[9] in 2016 and Aghadavoudi O et al[10] in 2018 where authors assessed obese subjects under general anesthesia with demographic data comparable to the present study.

The study results showed that on assessing the demographic data in two groups of study subjects, it was seen that the mean BMI in the face mask and nasal mask ventilation group was 29.95±2.75 and 30.38±2.38 kg/m2 respectively. The mean height was 164.14±7.09 and 164.26±6.78 cm in the face mask and nasal mask ventilation group respectively. Adjusted body weight in the face mask and nasal mask ventilation group was 66.91±7.44 kg and 67.47±7.55 kg respectively, whereas, actual body weight in the face mask and nasal mask ventilation group respectively was 80.82±9.10 and 82.20±8.85 kg. Neck circumference was 35.42±3.54 and 36.21±3.41cm in the face mask and nasal mask ventilation group respectively. There were 35.5% (n=32), 57.7% (n=52), and 6.66% (n=6) subjects respectively in ASA status I, II, and III in the face mask ventilation group and 57.77% (n=52), 17.7% (n=16), and 24.4% (n=22) subjects from ASA status I, II, and III respectively from nasal mask ventilation group. STOP-BANG scores of 0, 1, 2, 3, and 4 were seen in 31.1% (n=28), 24.4% (n=22), 28.8% (n=26), 8.88% (n=8), and 15.5% (n=6) subjects from face mask ventilation group and in 17.7% (n=16), 22.2% (n=20), 20% (n=18), 33.3% (n=30), and 15.5% (n=6) subjects respectively from nasal mask ventilation group. These data were consistent with the studies of Rehdar KJ et al[11] in 2018 and Hart D et al[12] in 2013 where the adjusted body weight, neck circumference, mean height, and actual body weight reported by the authors in their study subjects were comparable to the results of the present study.

It was seen that for the comparison of ventilation parameters in two groups of study subjects, it was seen that mean plateau pressure was significantly higher in the face mask ventilation group with 16.64±2.54 cmH2O compared to 12.02±1.19 cmH2O in the nasal mask ventilation group with p=0.001. the oxygen saturation was 99.59±0.95% in the face mask ventilation group and 99.62±1.02% in the nasal mask ventilation group. The difference was statistically non-significant with p=0.44. A similar non-significant difference was seen for end-tidal carbon dioxide levels that were 30.14±2.25 mmHg in the face mask ventilation group and 28.87±1.82 mmHg in the nasal mask ventilation group with p=0.14. These results were in agreement with the findings of Misra A et al[13] in 2009 and Liang Y et al[14] in 2008 where, similar to the present study, authors reported comparable parameters in their study subjects.

Concerning the comparison of ventilation parameters in face mask ventilation and nasal mask ventilation groups, PIP (peak inspiratory pressure was significantly higher in face mask ventilation group with 19.92±3.03 cmH2O compared to 14.77±1.36 cmH2O in nasal mask ventilation group with p=0.001. The air leak was significantly higher in the face mask ventilation group with 31.61±21.54 mL compared to16.42±22.14 mL in the nasal mask ventilation group with p=0.001. Expired tidal volume was 436.88±49.48 mL in the face mask ventilation group and 455.96±55.62 mL in the nasal mask ventilation group with p=0.001. Expired tidal volume was statistically non-significant in the face mask and nasal mask ventilation group with 436.88±49.48 and 455.96±55.62 mL with p=0.07. A similar non-significant difference was seen for set tidal volume with p=0.54. These findings were in line with the studies of Leoni A et al[15] in 2014 and Sato Y et al[16] in 2013 where authors reported significantly higher PIP and air leak in face mask ventilation compared to nasal mask ventilation as seen in the results of the present study.

CONCLUSIONS

Within its limitations, the present study concludes that nasal mask ventilation has higher efficacy compared to face mask ventilation and can be used as an alternative to face mask ventilation in obese subjects with BMI >25 kg/m2 under general anesthesia. Further prospective longitudinal studies with higher sample sizes are needed to reach a definitive conclusion.

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S. No	Parameter	Group I (face mask) n=90	Group II (nasal mask) n=90)
1.	**Mean age (years)**	41.65±10.52	43.14±12.86
2.	**Gender n (%)**		
a)	Males	40 (44.4)	38 (42.22)
b)	Females	50 (55.5)	52 (57.77)
3.	**BMI (kg/m2)**	29.95±2.75	30.38±2.38
4.	**Height (cm)**	164.14±7.09	164.26±6.78
5.	**Adjusted body weight (kg)**	66.91±7.44	67.47±7.55
6.	**Actual body weight (kg)**	80.82±9.10	82.20±8.85
7.	**Neck circumference (cm)**	35.42±3.54	36.21±3.41

8.	**ASA status**		
a)	I	32 (35.5)	52 (57.77)
b)	II	52 (57.77)	16 (17.7)
c)	III	6 (6.66)	22 (24.4)
9.	**STOP-BANG score**		
a)	0	28 (31.1)	16 (17.7)
b)	1	22 (24.4)	20 (22.2)
c)	2	26 (28.8)	18 (20)
d)	3	8 (8.88)	30 (33.3)
e)	4	6 (15.5)	6 (15.5)

Table 1: Demographic and anesthetic parameters in the study subjects

S. No	**Parameters**	**Group I (face mask) n=90**	**Group II (nasal mask) n=90)**	**p-value**
1.	**Plateau pressure (cm H2O)**	16.64±2.54	12.02±1.19	**0.001**
2.	**Oxygen saturation (%)**	99.59±0.95	99.62±1.02	0.44
3.	**EtCO2 (mmHg)**	30.14±2.25	28.87±1.82	0.14
4.	**PIP (cmH2O)**	19.92±3.03	14.77±1.36	**0.001**
5.	**Air leak (mL)**	31.61±21.54	16.42±22.14	**0.001**
6.	**Expired tidal volume (mL)**	436.88±49.48	455.96±55.62	0.07
7.	**Set tidal volume (mL)**	468.51±52.20	472.40±52.99	0.54

Table: Comparison of different ventilation parameters in two groups of study subjects