

Comparison of Ventilation Quality during Induction of General Anesthesia through Nasal and Face Mask Methods in Patients with Body Mass Index of Greater than 25

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Background: Face mask ventilation has a distinct place in anesthesiology. One of the difficulties (obstacles, problems) with a mask, is laryngeal airway obstruction caused by the backward displacement of the tongue and soft tissue which is further exacerbated by obesity (body mass index over 25). Considering the fact that ventilation using a nasal mask appears to cause fewer problems especially in obese patients, we decided to compare the quality of ventilation after the induction of general anesthesia using ventilation through an anatomical face mask and anatomical nasal mask in patients with a body mass index (BMI) over 25 in this study.

Methods: The study was a clinical trial, conducted on 70 patients between the ages of 18 and 70 years, with a BMI over 25, who were candidates for elective orthopedic surgery under general anesthesia at the Alzahra Hospital operating room. After evaluation of the inclusion criteria, the subjects were selected. Once placed on the operating table, the patients were administered 100% oxygen using a face mask held at proximity to the face for 3 minutes, after which anesthesia induction medication were administered to all patients. Subsequently, the patients were randomly divided into 2 groups. In the first group, ventilation was undertaken using the standard mask ventilation with 100 % oxygen for 3 minutes. In the second group, ventilation was performed through an anatomical nasal mask. The mean expiratory volume, mean SpO₂, mean end tidal CO₂ (Et CO₂) and mean airway pressure were measured, recorded and compared in both groups.

Results: From the ventilation parameters, maximum airway pressure during the 2nd minute after initiation of mask ventilation was significantly higher in the face mask group compared to the nasal mask group (4.6 +/- 1.6 and 12.5 +/- 1.7 respectively, p< 0.001) and the SpO₂ at this time was higher in the nasal mask group compared to the face mask group (97.6 +/- 1.7 and 95.3 +/- 3 respectively, p< 0.001). Other parameters related to ventilation did not show any significant difference.

Conclusion: According to the findings in this study, it can be concluded that ventilation with a nasal mask is more efficient than a face mask in patients with a BMI> 25 and is followed by a reduced amount of risk and complications.

Keywords: Face mask; Nasal mask; Ventilation; Induction of general anesthesia; BMI>25

Ventilation through a face mask is one of the essential skills that usually requires expert and meticulous opinion. Ventilation through a face mask while preserving spontaneous breathing, during induction and maintenance of general anesthesia using inhaled anesthetics is one of the most essential and minimally invasive methods of anesthesia well suited for short surgical procedures and all other patients, except those with a high risk of vomiting and regurgitating gastric contents. Face masks are also used for controlled ventilation before and after endotracheal

intubation. They are designed to create a seal around the mouth and nose. There are two essential points that should be considered when using a face mask; first, creating a complete seal between the mask and face with no gas leaks, and the other, is patency of the airway that should constantly be assessed. The quality of the seal can be determined by observing the filling and movement of the reserve bag of the mask. Gas leak usually takes place around the nose and cheeks. On the other hand, signs of airway obstruction depend on the location and extent of obstruction and whether positive pressure ventilation (PPV) or spontaneous breathing is being used. The most important signs of obstruction are recognized clinically. Noisy breathing (snoring in supraglottic stenosis and inspiratory stridor in glottis stenosis may occur) is a classic sign in airway obstruction during spontaneous breathing [1].

One of the difficulties during mask ventilation is laryngeal airway obstruction due to backward displacement of the tongue and soft tissue. Neck extension has been shown by radiological studies, to be the most effective maneuver to

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open the laryngeal airway. In addition, thrusting the temporomandibular joint (TMJ) anteriorly can also be effective. If these two maneuvers prove to be unsuccessful, devices such as oropharyngeal and nasopharyngeal airway and an SAD should be used [1-3].

Mask ventilation is one of the most common methods used at the beginning of general anesthesia. But in some occasions difficult ventilation may occur. A study conducted by Langron et al. reported the incidence of difficult ventilation to be 5 %, which is significantly correlated with difficult intubation. In this study, factors like presence of facial hair, obesity (BMI>25), lack of or missing teeth, age over 55 years and a positive history of snoring and difficult ventilation were predictive of difficult ventilation [4]. Another common problem faced when using a face mask is the potential for ophthalmological or facial nerve damage. Exerting downward force to the face mask, in order to create a seal is not feasible, particularly in patients admitted with facial or ophthalmological trauma. As a result, effective ventilation does not take place in such cases [5]. Moreover, researchers believe that mouth to nose breaths in resuscitation of apneic patients creates a more reliable airway than mouth to mouth breaths [6]. Another theory states that ventilation with a nasal mask in non-paralyzed adults with apnea during anesthesia is more effective than an anatomical face mask, removing more CO₂ from the lungs while generating a greater tidal volume in such patients [7]. Considering the fact that, in the face-mask method, there may be the possibility of the presence of a leak around the nose and cheeks, inability to apply pressure in order to create a seal, especially in patients admitted with ophthalmological trauma, and also considering difficult ventilation using a face-mask in obese patients, patients with facial hair and edentulous patients, the experience and presumption of the investigator is that the previously mentioned difficulties, particularly in obese patients exist to a lesser extent. Plus, in nasal mask ventilation, since there is no positive pressure applied to the soft tissue of the tongue and mouth and all the inspiratory tidal volume enters the airway through a relatively rigid course in the nasal cavity which is less likely to be obstructed during ventilation. This is more significant in patients with difficult ventilation. In the current study, this method is evaluated in obese patients, so that it can be evaluated in other patients with difficult ventilation upon approval. As a result, the present study was designed to compare the nasal mask method at this time, with the traditional and classic anatomical face mask method in patients with a BMI> 25.

Methods

This was a single-blind clinical trial study in which 70 patients between the ages of 17 and 70 years, who were candidates for surgery under general anesthesia were selected using simple improbable method and later divided into two groups using sample grouping (randomization was done with the Randomization software). Having a body mass index (BMI) of more than 25 kg/m².

Inclusion criteria: Having a body mass index (BMI) of more than 25 kg/m², having no apparent deformity or fracture in the face, having no acute or chronic lung disease, age between 18 and 70 years, candidates for elective surgery under general anesthesia.

Exclusion criteria: Not having the possibility to be ventilated using the selected method or having to use an oropharyngeal airway or a face mask plus neck extension in this case.

After obtaining approval from the research committee of the Anesthesiology Department of the Isfahan University of Medical Sciences, and obtaining written consent from all the patients, preoperative visit was done by an anesthesiologist the prior night. The inclusion criteria were assessed and necessary explanations of this method presented to the patients.

Preoperative orders included fluid therapy during the NPO period and administering premedication. On the day of surgery, patients were placed on the surgical table and then pre-oxygenated for 3 minutes, using 100% oxygen through a mask held at close proximity to the face. After that, anesthesia induction medication including, a bolus injection IV injection of sodium thiopental 5 mg/kg, fentanyl 2 mc/kg, midazolam 0.03 mg/kg were administered to all the patients. Patients were divided into two groups past this point, based on randomization done using the computer software. In the first group, ventilation was performed using the standard anatomical face mask and 100% oxygen for 3 minutes. In the second group, ventilation was undertaken using the investigators new method with a nasal mask. In both groups, patients were placed under ventilation with a controlled mode of the anesthesia machine with 8 cc/kg tidal volume, and a rate of 12 breaths /min. The mean expiratory tidal volume, mean SpO₂, mean end tidal CO₂ (EtCO₂), mean maximum airway pressure in three consecutive breaths in the 2nd minute after initiating ventilation, were measured, recorded and compared in both groups. After performing endotracheal intubation, securing the tube and connecting the patient to the anesthesia machine, all the above mentioned parameters were measured in the fifth minute after endotracheal intubation. In particular, the mean expiratory volume at this time, was particularly compared to the mean expiratory volume before intubation as the standard parameter. Hemodynamic changes including heart rate, systolic and diastolic blood pressure were also compared between the two groups.

The data was extracted, classified and entered into the software. Statistical analysis was performed using SPSS version 22 software. Comparison of the quantitative data related to ventilation and demographics between the two groups was performed using chi-square, T-test and analysis of variance by repeat comparison. A P value less than 0.05 was considered significant.

Results

35 patients with a mean age of 41.48 +/- 12.26 consisting of 18 males and 17 females were included in the face mask group and 35 patients with a mean age of 39.37 +/- 11.12 years consisting of 19 males and 16 females were included in the nasal mask group. The demographic parameters of the patients in both groups are compared in (Table 1).

As shown, the age, gender, height, weight and BMI of the participants in the two groups did not demonstrate a significant difference (p> 0.05). The factors related to quality of ventilation in the face mask and nasal mask groups are shown in (Table 2). As is apparent, the mean maximum airway pressure in the 2nd minute after ventilation is significantly higher (p<0.001) in the face mask

group (14.6+/- 1.6) than the nasal mask group (12.4 +/- 1.7). The SpO₂ level in the 2nd minute after initiating mask ventilation is higher in the nasal mask group (97.6+/- 1.7) than the face mask group (95+/-3) which is statistically

significant (p<0.001). The remaining parameters related to quality of ventilation in both groups did not demonstrate a significant difference (Table 2).

Table 1- Comparison of demographic characteristics of participants in both groups.

Variable	Face mask	Nasal mask	P value
Age(years)	41.48+/- 12.2	39.4 +/- 11.1	0.45
Gender(male/female)	18/ 17	19/16	0.81
Weight(kgs)	92.7 +/- 13.6	88.9+/- 11.3	0.202
Height(cms)	169.5 +/- 8.2	169.4 +/- 6.8	0.96
BMI(kg/m ²)	32.58 +/- 6.19	31.12 +/- 4.78	0.28
BMI(kg/m ²)	32.58 +/- 6.19	31.12 +/- 4.78	0.28

Table 2- Comparison of parameters related to quality of ventilation

Variable	Face mask	Nasal mask	P value
Set V _T	731.4 +/- 96.3	708.6 +/- 87.1	0.279
Exp. V _T in 2 nd min after initiation of MV	547.2 +/- 72.9	530.8 +/-56.1	0.29
Exp. V _T in 5 th min after ETi	639.9 +/- 85.7	619.7 +/- 67.1	0.27
Max Paw 2 nd min after MV	14.6 +/- 1.6	12.5 +/- 1.7	>0.001
Max Paw in 5 th min after ETi	15.4+/- 1.4	15.1+/- 1.7	0.39

Discussion

Nasal mask ventilation is routinely used for anesthesia in dentistry and for generating positive pressure in continuous positive airway pressure (CPAP) in obstructive sleep apnea (OSA) [5, 6]. The mechanism of action of a nasal mask in providing patency of the upper airway appears to be similar to anesthetized patients [8]. Various studies have compared the role of nasal mask and face mask in the treatment of OSA using CPAP. The majority of these studies have reported greater patient compliance and satisfaction, less respiratory difficulty during sleep and a better sleep pattern using a nasal mask than a face mask [9-11]. Difficult mask ventilation may be related to narrowing of the space posterior to the tongue and the consequent airway obstruction. This phenomenon, is created, similarly to OSA by the posterior displacement of the tongue, uvula and epiglottis [12], justifying the fewer number of non-ventilation cases in the nasal mask group compared to the face mask group.

One of the quantitative measures related to the quality of ventilation in this study, is Spo₂, which was significantly higher in the nasal mask group (p, 0.001). This measure is defined as the percentage of hemoglobin, which is saturated with oxygen.

Therefore, under similar conditions in both groups, when Spo₂ is higher in one group, it can be an indication that more oxygen is being delivered to the patient, probably showing more efficient ventilation when using a nasal mask. One should keep an important point in mind, that in the nasal mask group, the oxygen saturation percentage in the 2nd minute after starting mask ventilation was roughly 97.6% while around 95% for the face mask group during the same period. As it is evident, these figures are significant

based on both statistical analysis and clinical importance.

Another result of the present study was the lower airway pressure in the nasal mask group. The airway pressure was measured in the entirety of the breathing circuit which consisted of both the patients' airway and the breathing circuit connected to him/her. A higher pressure indicated that there was a higher resistance in the circuit and a higher pressure needed to be applied from outside to provide sufficient ventilation. The higher airway pressure in the face mask group can be assessed from different perspectives. Firstly, it indicates that in this method, increased pressure is a way to overcome the mechanical obstruction occurring in the airway, which correlates with the mechanisms of creating a higher pressure in the oral cavity by a face mask. On the other hand, increased airway pressure can be concomitant with some complications including increased air insufflation in to the stomach and increased risk of regurgitation and aspiration of gastric contents [13]. In 2008, Liang et al. conducted a comparative study between nasal mask ventilation and combined nasal and oral mask ventilation in adult patients, under general anesthesia. In this study, 50 patients were subjected to ventilation, initially by combined oral and nasal mask and subsequently by nasal mask. Parameters related to ventilation were measured and recorded in both situations. It was finally reported that nasal mask provided significantly more efficient ventilation compared to oral-nasal mask ventilation (lower airway pressure, higher CO₂ removed and higher expiratory tidal volume) [7].

Hemodynamic changes occurred similarly between the two groups. Decreased blood pressure and increased heart rate during induction of anesthesia which are common and predictable findings, can be caused by the medications used at this stage, especially sodium thiopental and opioids,

making hypotension the most common complication at this stage [14]. Which was not related to the method of ventilation in patients.

Conclusion

Considering the possibility of difficult ventilation with an anatomical face mask in obese patients, patients with facial hair and edentulous patients, and considering the fact that, in whole face mask ventilation, a leak may appear around the nose and cheeks, and also the fact that applying downward pressure to the mask in order to create a sufficient seal may not be feasible particularly in patients admitted with facial and ophthalmological trauma, since ventilation with a nasal mask does not incur any positive pressure on the soft tissue of the tongue and oral cavity and the entire tidal volume enters the larynx and airway through a rigid course in the nasal cavity, causing less airway obstruction during ventilation, it appears that using a nasal mask is more efficient than the previous (face-mask) method.

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