A Single-center, Prospective, Cross-over Study to Compare the Efficiency of Oxygen Supply between the OxyMask™ and Non-rebreather Mask in Healthy Adults

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Purpose: In this single-center, prospective, randomized, cross-over study, we compared the efficiency of oxygen supply between OxyMask and non-rebreather mask (NRM), depending on the position of the mask.

Methods: Either OxyMask or NRM was applied to 33 healthy volunteers, in a random manner, on the upper (that 1 cm upper to it), lower (that 1 cm inferior to it) and lateral malposition (that 1 cm lateral to it). After a 3-minute oxygenation, at a flow rate of 15 L/min, we measured the fractional expired oxygen concentration (FEO₂), fractional expired carbon dioxide concentration (FECO₂), and visual analogue scale (VAS) scores for the degree-of-wearing sensation.

Results: OxyMask showed a lower level of FEO₂ as compared with NRM in all positions. Moreover, OxyMask showed no significant difference between FEO₂ and the position of the mask. However, NRM showed a significantly lower FEO₂ in the upper and lateral malposition. FECO₂ had no significant difference with the types and position of the mask. The mean VAS scores for the degree-of-wearing sensation were 2.2 ± 1.5 in the OxyMask and 4.3 ± 1.5 in the NRM (p<0.001).

Conclusion: OxyMask may offer greater benefit in maintaining the concentration of supplied oxygen and provide greater comfort than NRM in patients with difficulty applying the mask on an adequate location and maintaining the seal.

Key Words: Oxygenation, Carbon dioxide, Mask, Visual analogue scale

Introduction

In the emergency airway management for patients with respiratory distress, it would be mandatory to continuously supply high-concentration oxygen1,2). The efficiency of oxygen supply is determined based on the degree of denitrogenation through end expiratory oxygen fraction (FEO₂) monitoring, which is commonly performed in an operating room3). In a pre-hospital or emergency care setting, however, it is difficult to monitor the efficiency of oxygen supply for the airway management in patients with respiratory or circulatory compromise. This may frequently cause inadequate oxygen supply4). It can therefore be inferred that the efficient and safe oxygen supply might be essential for the airway management in a pre-hospital or emergency care setting.

Non-rebreather face mask (NRM) is commonly used to supply high-concentration oxygen prior to the advanced airway management in a pre-hospital or emergency care setting. In addition, sealing of the mask is an essential procedure for the efficient oxygen supply. That is, poor sealing of the mask would greatly lower the efficiency of oxygen supply5). NRM can be simply attached to patients using a rubber band; this is sufficient to supply high-concentration oxygen for patients, as theoretically postulated. The NRM is therefore widely used in a pre-hospital or emergency care setting. But there are
some problems with sealing of the NRM. That is, it may be attached to incorrect sites in uncooperative patients; this may cause poor sealing of the NRM. On the other hand, adequate sealing of the NRM may also raise the possibility of carbon dioxide retention6).

The OxyMask (Southmedic Inc., Barrie, ON, Canada) is a novel type of mask that has recently been developed to supply high-concentration; it does not require sealing. It is an open system whose diffuser was designed to deliver high-concentration oxygen to the target site. Its advantages include carbon dioxide (CO2) clearance and user convenience 6). Still, however, there is a paucity of data regarding its efficiency in the emergency airway management.

Given the above background, we conducted this study to compare the efficiency of oxygen supply and CO2 clearance depending on the sites of application and subjective wearing sensation between the OxyMask and the NRM.

Materials and Methods

1. OxyMask

Most of the respiratory devices are equipped with a diffuser that has been designed to supply oxygen in a laminar flow pattern. That is, the diffuser is involved in mixing oxygen with room air and generating a turbulent flow when its velocity reaches a certain level (approximately 8 L/min)5). This is followed by a marked reduction in fraction of inspired oxygen (FiO2)5).

But the OxyMask is equipped with a specially-designed diffuser, composed of a cup and a pin, emitting oxygen in a mushroom-shaped pattern9). Thus, it delivers the vortex to the face during inspiration6). The vortex prevents oxygen from being mixed with room air, thus maintaining a consistent level of FiO2 simply by adjusting the oxygen flow rate1).

Once emitted from the diffuser in a mushroom-shaped pattern, oxygen maintains a relatively higher level of FiO2 up to a distance of 1.5 cm. At a distance of >1.5 cm, however, there would be a marked decrease in FiO2. Therefore, the OxyMask has a diffuser placed in the nasal philtrum that is 1.3 cm distant from the face9). Moreover, the OxyMask is an open system. It can therefore be inferred that its efficiency of CO2 clearance is relatively higher6,7).

2. Non-rebreather mask

NRMs have simple valve system. It has 3 disc valves. So patient can inspirate oxygen in the reservoir bag not mixed with room air. And can expirate oxygen outside of the mask through the valve. This structural points make it possible to serve invariable, high FiO2 regardless of peak inspiratory flow ratio10). So these devices are now commonly used in hospital.

But NRM serves oxygen by passive inspiration, it has low-flow characteristics. And a potential lack of effective washout of exhaled gases, it can lead to rebreathe CO210-13).

We used standard adult nonrebreather mask with reservoir and safety vent (GaleMed Xiamen Co., Xiamen, Fujian, China).

3. Sample size estimation

This study was planned to compare the level of F2O2 between OxyMask and nonrebreather face mask in the randomized crossover design. According to previous studies, we assumed the clinically significant difference of 5% in F2O2 stated as coequal with approximately and extra 30 seconds of safe apnea time ([5% × 2,400 mL/oxygen consumption at 250 mL/min]) in an 80 kg man and a within-participant variability of 6%. The sample size was calculated at 28 subjects with a statistical power of 85% and a significance level of 0.05 by the
sample size calculation program, PASS 12 version (Hintze, J. (2013). PASS 12. NCSS, LLC. Kaysville, Utah, USA. www.ncss.com). Considering the dropout rate of 15%, 33 subjects were required for this study.

4. Study patients and setting

A total of 33 healthy individuals who are engaged in an emergency care center of our medical institution participated in the current prospective, randomized, crossover, observational study. They had no conflict of interest in relation to it.

Exclusion criteria for the current study are as follows: (1) The individuals with cardiac or pulmonary diseases, (2) The individuals who are taking drugs for the treatment of cardiac or pulmonary diseases (e.g., inhalers), (3) Pregnant women, (4) The individuals with excessive hair or a past history of facial injuries.

We therefore enrolled a total of 33 individuals who met eligibility criteria as the subjects in the current study. All the subjects submitted a written informed consent. The current study was approved by the institutional review board of our medical institution (SCHCA 2016-06-018).

In the current study, we enrolled a total of 33 healthy individuals and randomly divided them into two groups, the OxyMask group and the NRM group, using a computer-generated randomization table. The subjects of the OxyMask group were applied with the OxyMask. In addition, the subjects of the NRM group were applied with NRM. At baseline, we evaluated the age, sex, height, weight, respiratory rate, $F_{O2}$ and fractional expired carbon dioxide concentration ($F_{CO2}$). Thereafter, we performed a 3-minute oxygenation at a total of four sites that are arbitrarily selected from the mask, such as the adequate position and the upper (that 1 cm upper to it), lower (that 1 cm inferior to it) and lateral malposition (that 1 cm lateral to it). This is needed for pre-oxygenation prior to intubation. No clinical significance would be found from pre-oxygenation that is performed for more than three minutes14,15). We therefore set the duration of oxygen at three minutes. To examine the maximal efficiency of the mask, we supplied oxygen at a maximal oxygen flow rate of 15 L/min, which can be measured at our medical institution. The location of the displacement was determined by a single observer who used a ruler sticker with a width of 2 cm as well as four landmarks marked on the margin of the mask. The ruler sticker was attached to vertical and horizontal directions from the mid-face in such a condition that it was worn in the adequate position and there was an exact match between the landmark of the mask and the center of the width of the sticker. The sticker was thin enough not to interfere with sealing of the mask. (Fig. 1). During respiration, the subjects were not allowed to perform movement or verbal communication. Their tidal volume during daily lives was maintained. After a 3-minute respiration, the final inspiration was endured for the measurement of $F_{O2}$ and $F_{CO2}$. This was followed by expiration through a

Fig. 1. The positions of the mask. The location of the displacement was determined using a ruler sticker with a width of 2 cm as well as four landmarks (arrow) marked on the margin of the mask. The ruler sticker was attached to vertical and horizontal directions from the mid-face in such a condition that it was worn in the adequate position and there was an exact match between the landmark of the mask and the center of the width of the sticker. The sticker was thin enough not to interfere with sealing of the mask. (A) The adequate position of the OxyMask. (B) The lateral malposition of the OxyMask.
mouthpiece to a gas analyzer (CARESCAPE Monitor B650, GE Healthcare Finland Oy, Finland), for which we discontinued to supply oxygen to the mask to prevent oxygen from being contaminated. Then, we monitored F$_{2}$O$_{2}$, F$_{2}$CO$_{2}$ and respiratory rate until they recovered to baseline levels. These procedures were also performed for a total of four positions. In addition, the same procedures were also performed using one mask after another (Fig. 2).

We also measured the degree of wearing sensation using a 10-point visual analogue scale (VAS), with 0=no inconvenience in breathing and 10=inability to breathe. In the current study, changes in F$_{2}$O$_{2}$ and F$_{2}$CO$_{2}$ levels after a 3-minute oxygenation from baseline served as primary outcome measure. In addition, changes in the degree of wearing sensation on the VAS served as secondary outcome measures. And we compared both groups about primary and secondary outcomes.

5. Statistical analysis

Baseline and clinical characteristics of the subjects were analyzed. Categorical variables were expressed as the frequency and the percentage. In addition, continuous variables were expressed as mean $\pm$ standard deviation (SD) or median and quartiles. To analyze changes in F$_{2}$O$_{2}$ and F$_{2}$CO$_{2}$ at a 3-minute oxygenation from baseline were analyzed using the repeated measures analysis of variance. Sphericity was analyzed using Mauchly’s test. Moreover, Greenhouse-Geisser or Huynh-Feldt corrections were also performed where appropriate. A post-hoc analysis using the Bonferroni correction was performed to analyze statistical significance depending on the location in each group and that between the two groups. Differences in F$_{2}$O$_{2}$ and F$_{2}$CO$_{2}$ depending on the location between the two groups were expressed estimated as mean with 95% confidence interval (CI). All tests were two-tailed, and a $p$-value of $<$0.05 was considered statistically significant. The difference in the degree of wearing sensation on the VAS between the two groups was

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![Study Design Diagram](image.png)

**Fig. 2.** Study design. Thirty three enrolled volunteers randomly divided two groups and wear OxyMask or non-rebreather face mask, when measurements of different four position is ended (one cycle), they wore another mask and did one more cycle of measurements.
analyzed using the Wilcoxon’s signed rank test. Statistical analysis was done using the SPSS ver. 14.0 for windows (SPSS Inc., Chicago, IL) and R ver. 3.1.3 (R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org/).

### Results

1. Baseline characteristics of the subjects

The study population consists of 33 healthy subjects, comprising 18 men (54.5%) and 15 women (45.5%), with a mean age of 28.0 ± 5.2 years old, a mean height of 170.3 ± 8.6 cm, a mean weight of 66.6 ± 14.4 kg, a mean body mass index of 22.7 ± 3.3 kg/m² and a mean respiratory rate of 16.8 ± 2.6 breaths/min.

2. Differences in $F_{EO2}$ between the OxyMask and the NRM in adequate position

In the adequate position after a 3-minute oxygenation, $FEO2$ was 39.3% ± 4.9% in the OxyMask group and 54.5% ± 8.3% in the NRM group. This indicates that there was a difference in the mean $FEO2$ by 15.2% ± 9.1% between the two groups (95% CI, 12% to 18.4%) (Table 1, Fig. 3A).

#### Table 1. $FEO2$ (%) depending on the types and position of the mask

<table>
<thead>
<tr>
<th>Position</th>
<th>OxyMask</th>
<th>NRM</th>
<th>$\Delta FEO2$\textsuperscript{†} (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate position</td>
<td>39.3 ± 4.9</td>
<td>54.5 ± 8.3</td>
<td>15.2 ± 9.1 (12 to 18.4)</td>
</tr>
<tr>
<td>Upper malposition</td>
<td>40.5 ± 5.3</td>
<td>46.7 ± 8.3</td>
<td>6.2 ± 9.1 (3 to 9.4)</td>
</tr>
<tr>
<td>$\Delta FEO2$\textsuperscript{†} (95% CI)</td>
<td>1.2 ± 5.7 (-0.8 to -3.2)</td>
<td>-7.8 ± 8.5 (-10.8 to -4.8)</td>
<td></td>
</tr>
<tr>
<td>Lower malposition</td>
<td>38.8 ± 6.5</td>
<td>52.4 ± 9.7</td>
<td>13.6 ± 12 (9.3 to 17.8)</td>
</tr>
<tr>
<td>$\Delta FEO2$\textsuperscript{″} (95% CI)</td>
<td>-0.5 ± 3.1 (-1.5 to -0.6)</td>
<td>-2.1 ± 11 (-6 to -1.8)</td>
<td></td>
</tr>
<tr>
<td>Lateral malposition</td>
<td>39.2 ± 5.9</td>
<td>43.6 ± 8.6</td>
<td>4.4 ± 10.4 (0.7 to 8.1)</td>
</tr>
<tr>
<td>$\Delta FEO2$\textsuperscript{§} (95% CI)</td>
<td>-0.1 ± 5.2 (-1.9 to -1.8)</td>
<td>-10.9 ± 9 (-14.1 to -7.7)</td>
<td></td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation. $FECO2$: fractional expired carbon dioxide concentration, NRM: non-rebreather mask, CI: confidence interval

\textsuperscript{†} Difference between the adequate position and the upper malposition (upper-adequate).

\textsuperscript{‡} Difference between the adequate position and the lower malposition (lower-adequate).

\textsuperscript{§} Difference between the adequate position and the lateral malposition (lateral-adequate).

\textsuperscript{‖} Difference between the OxyMask and the NRM in the same position (NRM-OxyMask).

![Fig. 3. Boxplot of $FEO2$ (A) and $FECO2$ (B) depending on the types and position of the mask. Boxplots represent median and interquartile range (IQR) of each value. Whiskers represent the first and fourth quartiles, and dots do 1.5 × the IQR outside the first and fourth quartiles.](image)

NRM: non-rebreather face mask
3. Changes in \( F_{\text{E}}O_2 \) depending on the position of the mask

\( F_{\text{E}}O_2 \) had no significant difference with the position of the OxyMask and \( F_{\text{E}}O_2 \) had no significant difference with the adequate position and lower malposition of the NRM group. But it was significantly lower in the upper and lateral malposition of the NRM (Table 1, Fig. 3A).

4. Differences in \( F_{\text{E}}CO_2 \) between the OxyMask and the NRM

\( F_{\text{E}}CO_2 \) was 31.2% ± 4.6% in the OxyMask group and 31.1% ± 4.3% in the NRM group in adequate position. This indicates that there was no significant difference in the mean and \( F_{\text{E}}CO_2 \) by -0.1% ± 3.7% between the two groups (95% CI, -1.4% to -1.2%) (Table 2, Fig. 3B). And \( F_{\text{E}}CO_2 \) had no significant difference with the position in both groups (Table 2, Fig. 3B)

5. The VAS scores for the degree of subjective wearing sensation

The VAS scores for the degree of subjective wearing sensation were 2.2 ± 1.5 points in the OxyMask group and 4.3 ± 1.5 points in the NRM group (\( p < 0.001 \)).

### Discussion

Our results showed NRM supplied oxygen more efficiently than OxyMask in adequate position.

But, OxyMask could supply oxygen more invariably depending on the position of the mask than NRM. No differences in \( F_{\text{E}}CO_2 \) between the OxyMask and the NRM in any position. Subjective wearing sensation is better with OxyMask group.

Our results showed that OxyMask also maintained unique properties of the mask in malpositions. This indicates that oxygen can be supplied even in malpositions because high-concentration oxygen and vortex, formed in the diffuser of the OxyMask, are spread along the face. By contrast, the NRM showed a significant difference in the efficiency of oxygen supply depending on the position of the mask. This indicates that the role of NRM as a one-way valve and a reservoir would be diminished if located in inadequate positions. Moreover, it is also presumed that the influx of room air cannot be avoided. In uncooperative patients, such as infants or elderly or patients with altered mental state or patients who need long period of oxygen supply, it is difficult to maintain the adequate position of the mask. It would also be mandatory, however, to stably maintain oxygen supply without any alterations even in patients who cannot undergo continuous monitoring followed by correction of the malposition of the mask. This leads to the speculation that there might be a variability in the position of the mask, as described earlier. Our results indicate that the

### Table 2.

<table>
<thead>
<tr>
<th>Position</th>
<th>( F_{\text{E}}CO_2 ) (%)</th>
<th>OxyMask</th>
<th>NRM</th>
<th>( \Delta F_{\text{E}}CO_2 ) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate position</td>
<td>31.2 ± 4.6</td>
<td>31.1 ± 4.3</td>
<td>-0.1 ± 3.7 (-1.4 to 1.2)</td>
<td></td>
</tr>
<tr>
<td>Upper malposition</td>
<td>30.9 ± 4.6</td>
<td>31.4 ± 4.7</td>
<td>0.5 ± 3.3 (-0.7 to 1.6)</td>
<td></td>
</tr>
<tr>
<td>( \Delta F_{\text{E}}CO_2 ) (95% CI)</td>
<td>-0.3 ± 2.9 (-1.3 to 0.7)</td>
<td>0.3 ± 3.6 (-1 to 1.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower malposition</td>
<td>31.1 ± 4.6</td>
<td>31.0 ± 3.4</td>
<td>0 ± 3.8 (-1.4 to 1.3)</td>
<td></td>
</tr>
<tr>
<td>( \Delta F_{\text{E}}CO_2 ) (95% CI)</td>
<td>-0.2 ± 2.7 (-1.1 to 0.8)</td>
<td>-0.1 ± 3.3 (-1.2 to 1.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral malposition</td>
<td>31.3 ± 4.5</td>
<td>31.5 ± 4.2</td>
<td>0.2 ± 3.6 (-1.1 to 1.4)</td>
<td></td>
</tr>
<tr>
<td>( \Delta F_{\text{E}}CO_2 ) (95% CI)</td>
<td>0.1 ± 2.3 (-0.7 to 0.9)</td>
<td>0.4 ± 4.3 (-1.1 to 1.9)</td>
<td></td>
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</tr>
</tbody>
</table>

Values are mean ± standard deviation. \( F_{\text{E}}CO_2 \): fractional expired carbon dioxide concentration, NRM: non-rebreather mask, CI: confidence interval

\( \dagger \) Difference between the adequate position and the upper malposition (upper-adequate)

\( \ddagger \) Difference between the adequate position and the lower malposition (lower-adequate).

\( \& \) Difference between the adequate position and the lateral malposition (lateral-adequate).

\( \dagger \) Difference between the OxyMask and the NRM in the same position (NRM-OxyMask).
use of OxyMask rather than the NRM would be beneficial in maintaining the efficiency of oxygen supply in patients who cannot be continuously corrected for the malposition of the mask.

But the OxyMask showed a lower level of $F_{E}O_2$ as compared with the NRM in all positions. This might be because an oxygen flow rate of 15 L/min (250 mL/s) is lower than tidal volume of adults. Unlike the NRM, the OxyMask does not use reserved oxygen and supplied one at the same time but immediately do supplied one only. For instance, the respiratory rate is 15 breaths/min and the inspiration:expiration ratio is 1:2 in adult men with a height of 1.75 m and an ideal body weight. Under this assumption, the mean flow rate of oxygen needed for a single respiration is estimated at approximately 370 mL/s, which exceeds the amount of oxygen supply of the OxyMask at a flow rate of 15 L/min. If it is possible to supply oxygen at a flow rate of >15 L/min using the OxyMask, a larger amount of oxygen can be supplied. Moreover, stable oxygen supply with less alterations would become possible in adequate positions to some extents.

According to a manikin study, the OxyMask had a higher or similar degree of oxygen supply as compared with the NRM. It was different result from ours. As shown in the current study, however, we solely measured $F_{E}O_2$ and $F_{E}CO_2$ at the end of an expiratory reserve breath rather than concentrations around the oral cavity. We therefore assume that our results are more consistent with true end-alveolar oxygen, actual degree of oxygen reserve and the degree of CO$_2$ clearance.

In the NRM, $F_{E}O_2$ showed no significant difference in the inferior malposition as compared with the adequate position. If the mask is lowered by 1 cm, its lower margin would be remote from the chin. This suggests that the internal curvature and the chin of the subjects caused a sealing of the mask although its lower margin mostly got remote from the chin if it was lowered by 1 cm.

The OxyMask did not show statistically significant measurements. In the upper position, however, $F_{E}O_2$ was relatively higher. In the inferior position, it was relatively lower. To ensure the accuracy of experimental data, the subjects were not allowed to perform a verbal communication with others. This may induce the subjects to breathe using the nose only. In association with this, oxygen is supplied at a higher flow rate in the upper position where there is a close proximity between the diffuser and the nose. In the inferior position, converse phenomena may occur. This may cause different outcomes in an actual clinical setting.

OxyMask serve oxygen more invariably than NRM. In an actual clinical setting, we monitor patient’s blood oxygen saturation and respiratory rate, and etc. so we can serve oxygen more invariably for patients tolerable to supplying of relatively low oxygen concentration. But, OxyMask cannot serve oxygen more efficiently than NRM. So, it should need more studies to be used commonly in actual clinical setting.

With regards to CO$_2$ clearance, there was no significant difference in it in both adequate locations and inadequate ones. In addition, there were also no cases in which abnormal measurements were obtained. According to a manikin study comparing between OxyMask and NRM, OxyMask had a similar or higher profile of CO$_2$ clearance. That study also showed there was a variability in CO$_2$ clearance depending on the flow rate of oxygen and the respiratory rate of a manikin. It is therefore presumed that various results might also occur in an actual clinical setting. Basically, however, the NRM is a closed system. Therefore, due to these structural problems, there is a possibility of an imbalance between supplying oxygen flow and expiratory flow that may occur. We could not therefore rule out the possibility that CO$_2$ retention might occur in the NRM.

A subjective wearing sensation was found to be of higher degree in the OxyMask group as compared with the NRM group. In association with this, based on the structure of OxyMask as compared with the NRM, it was designed as an open system. A smaller size and weight might also be another cause. Presumably, these are merits in providing a more comfort for patients with claustrophobia or children. In addition, the OxyMask would also be beneficial in maintaining a nasogastric tube or maintaining oral hygiene as well as stabilizing psychological status from functional perspectives.

Moreover, the pattern of the oxygen supply of OxyMask is not associated with the sealing of the mask. Thus, as compared with the NRM, the OxyMask would become more useful in supplying oxygen for patients with a higher risk of inadequate application of the mask, such as those with edentulous jaws or facial injuries where it is difficult to seal the mask.
There are several limitations of the current study as shown below: (1) Critically-ill patients with may perform different pattern of respiration from normal healthy individuals. There is a possibility that tidal volume and minute volume might be increased or decreased. This may affect the efficiency of oxygen supply of the mask. Based on the current results, it can be inferred that the NRM rather than OxyMask would provide supply oxygen more efficiently at a flow rate of 15 L/min in both adequate and inadequate locations. This efficiency of the mask should be monitored on a real-time basis in the emergency airway management in an actual clinical setting. But there are no conventional types of equipments that are used to measure FEO₂ in an operating room. (2) Supply of oxygen at a higher flow rate of > 15 L/min would affect the efficiency of the mask. According to what has been studied, FiO₂ generated from OxyMask was found to be gradually increased even at a flow rate of > 15 L/min³. In a pre-hospital or emergency care setting, however, a conventional type of equipments cannot measure a flow rate of > 15 L/min. Further studies are therefore warranted to examine the efficiency of oxygen supply of the mask at a flow rate of > 15 L/min and in adequate sites. (3) The current study was solely conducted in adults. There is a variability in respiratory physiology depending on the age. This may affect the efficiency of the mask. The OxyMask would show a higher efficiency of oxygen supply even at a flow rate of < 15 L/min in patients with a lower tidal volume. Further studies are therefore warranted to examine the efficiency of OxyMask in individuals in varying age ranges.

**Conclusion**

The OxyMask would be more beneficial in maintaining the concentration of supplied oxygen and it would be more comfortable than the NRM in patients where it is difficult to apply the mask to the adequate location and to maintain the sealing of it. This is one of its advantages over the NRM for which emergency department physicians should pay special attention to possible alterations in the efficiency of oxygen supply of the NRM, although delivering a larger amount of oxygen, when it is applied to inadequate positions.

**Conflict of Interest**

The authors have nothing to disclose in relation to the current study.

**References**

