Case Series
Volume 10:3, 2020
DOI: 10.37421/2161-105X.2020.10.500

Journal of
Pulmonary & Respiratory Medicine

ISSN: 2161-105X

Open Access

Use of modified full face scuba-diving mask in patients with respiratory insufficiency due to Covid-19 infection

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Abstract

Background: The COVID-19 pandemic has made it necessary to implement new ways to increase the volume of oxygen delivered to infected patients with respiratory involvement. When treating individuals who are not candidates for intubation, we have found that modified scuba-diving masks may be used to treat those cases requiring over 15 liters of oxygen per minute, like compassionate use.

Methods: We describe the use of modified scuba-diving masks for ventilation on 13 patients at out hospital. None of them was candidate for ICU due to comorbidity and dependency.

Findings: Patients outfitted with this modified scuba-diving masks experience immediate clinical improvement, showing an increase in oxygen saturation from 80–84% to 96–98%, with isolated cases reaching 100% saturation. Preliminary results reveal hypercapnia closely resembling that seen with a normal reservoir as well as improved oxygen saturation. The clinical evolution was favorable. Patients progressively decreased their oxygen supply needs: 8 of them have undergone this treatment for 8 days (4 patients have already been discharged; one maintains FiO2 28% with nasal cannula and 3 require intermittent treatment); 2 patients continue with the masks. 3 patients have died.

Conclusion and Interpretation: Through a series of adaptations, these masks may be used to increase the volume of oxygen delivered, thereby avoiding the use of a respirator or achieving more effective management of hospital resources in situations of potential disease transmission, such as the current pandemic situation in which we currently find ourselvesl.

Keywords: COVID-19 • Ventilation • Dual therapy • Full-face mask • Respiratory insufficiency

Case Series

During the ongoing Covid-19 pandemic, several novel approaches to the management of infected patients with to increase the volume of oxygen delivered have emerged. The treatment possibilities are different depending on the characteristics of the patients [1].

In The Lancet Respiratory Medicine, Matthay and colleagues [2] provide recommendations of treatment for severe acute respiratory distress syndrome from COVID-19. Ramanathan et all. [3] recommend the use of extracorporeal membrane oxygenation (ECMO) for patients with respiratory failure.

When treating individuals who are not candidates for intubation due to such factors as the presence of multiple conditions associated with advanced age or intermediate-stage disease [4], we have found that modified scuba-diving masks can be used to treat those cases requiring over 15 liters of oxygen per minute, like compassionate use.

We present the preliminary results in a short series of 13 patients.

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Received 10 May, 2020; **Accepted** 26 May, 2020; **Published** 02 June, 2020

The diving mask works like a "fullface" CPAP for non-invasive respiratory therapy [5,6]. The intake orifice receives oxygen through a dual connection outfitted with standard 5-mm tubes connected to a double oxygen flowmeters, each with a capacity of 15 l/min (30 liters in total). Alternatively, two single sensors can be used in parallel. (Figure 1)

LINK TO VIDEO

Furthermore, we are testing a series of modifications that would enable us to assess the effect of this therapy on the alveolar membrane.

The PEEP valve at the air outlet has been placed to create a positive pressure inside the mask. By doing this, we created a positive airway pressure of between 7 and 12 cm H2O in the mask interior The pressure with the masks remains stable with small oscillations in oxygen concentration less than 3% (except in very deep inspirations) (Figure 2). It also has the advantage that It seals very well with low leaks. Expelled air passes through an antiviral breathing to prevent contamination outside the device. Further, two diving masks were modified to introduce an enteral feeding cannula (Figure 3). Enteral feeding in these patients avoids the prolongation of parenteral feeding devices and reduces malnutrition [7].

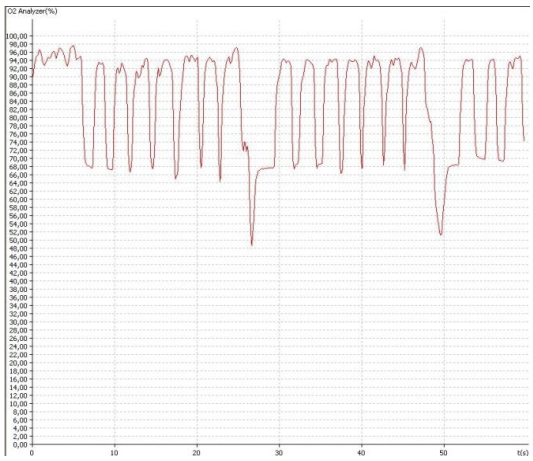
Our hospital currently has 13 patients who are receiving ventilation with this system, mean age of 83, 05 years (range between 77 and 98). No one candidate for ICU due to comorbidity (Charlson Comorbidity Index) and dependency (Barthel Index for Activities of Daily Living).

We have included serial arterial blood gas analysis to the clinical follow-up of patients outfitted with this system.

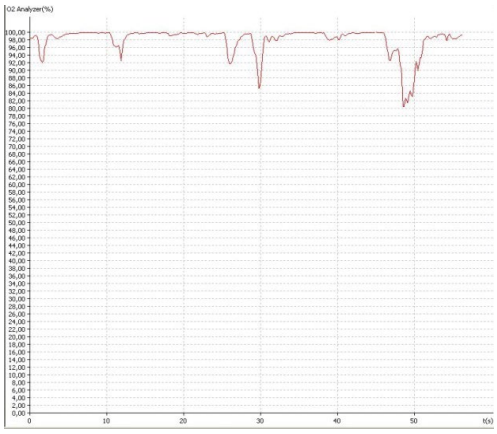
Masks connected to reservoir bags have a maximum oxygen flow of 15 liters per minute, and they obtain an oxygen IF between 40 and 70%, depending on the type of mask and the inspiratory flow, while this modified scuba-diving mask outfitted with a double flowmeters has reached a volume of 30 liters per minute (Figure 2). In addition, we have observed no air leaks in the area surrounding the face, getting an oxygen IF near 100%, marking an improvement over other systems such as the Venti mask.

Patients outfitted with this modified mask following failure of a nonrebreather mask experience immediate clinical improvement, showing an increase in oxygen saturation from 80–84% to 96–98%, with isolated cases reaching 100% saturation (Figure 4).

Figure 1. Modified full face scuba-diving mask.



A)



B)

Figure 2. Oxygen concentration inside the mask a) Masks connected to reservoir bags b) modified scuba-diving mask outfitted with a double flowmeters has reached a volume of 30 litres per minute. Note the effect of deep inspiration.

Figure 3. Patient, before placement of the modified scuba-diving mask; O_2 saturation appears on the monitor.

Figure 4. Patient, after placement of the modified scuba-diving mask; O_2 saturation appears on the monitor.

Preliminary results reveal hypercapnia closely resembling that seen with a normal reservoir as well as improved oxygen saturation. The maximum PaCO2 obtained in our samples was 49 mmHg.

The clinical evolution was favorable in most cases, patients progressively decrease their oxygen supply needs: 8 of them have undergone this treatment for 8 days (4 patients has already been discharged; one maintains FiO2 28% with nasal cannula and 3 require intermittent treatment); 2 patients continue with the masks. 3 patients have died.

Through a series of adaptations, these masks may be used to increase the volume of oxygen delivered, thereby avoiding the use of a respirator or achieving more effective management of hospital resources in situations of potential disease transmission.

LINK TO STL FILES

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How to cite this article: Maria, Herrera, Jorge Alvarez, Gutierrez Jimenez and Gonzalez Mangado, et al. "Use of Modified Full Face Scuba-Diving Mask in Patients with Respiratory Insufficiency due to COVID-19 Infection." J Pulm Respir Med 10 (2020): 500.