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LETTER TO THE EDITOR

Mild hyperbaric oxygen and oxygenation under normobaric conditions: response to Dr. Andel's letter submitted to the editor

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A previous study [1] investigated oxidative stress and antioxidant levels in rats exposed to different oxygen concentrations (ranging 14.4–82.2%) under normobaric conditions (1013 hPa) for 24 h. The results obtained in that study [1] were not appropriate to apply and compare with those observed after exposure to mild hyperbaric oxygen, at 1226–1317 hPa with 35–40% oxygen for 1–6 h [2], as suggested by Dr. Andel. Therefore, I withdraw the content, which was described in a recent review article [2], that a treatment with more than 40% oxygen under normobaric conditions can possibly cause side effects, e.g., excessive levels of oxidative stress, because there is no previous study that investigated the time-dependent side effects of high oxygen concentration under normobaric conditions on oxidative stress levels.

When remaining in mild hyperbaric oxygen at 1317 hPa with 40% oxygen, the content of dissolved oxygen is 1.02 mL/dL blood plasma, where the vapor pressure, concentration of carbon dioxide in the alveolus, and respiratory exchange ratio are set to 47 mmHg, 40 mmHg, and 0.8, respectively (it is difficult to measure directly the content of dissolved oxygen in the blood plasma. Therefore, the content of dissolved oxygen was estimated by a mathematical formula). Breathing with 40% oxygen, which is automatically regulated by a control unit including an air-pump, a computer, and an oxygen concentrator, is possible when staying in a mild hyperbaric oxygen chamber at 1317 hPa, because the chamber has ample space and oxygen concentration in the chamber is not affected by carbon dioxide induced by expiration. To obtain the similar content of dissolved oxygen under normobaric conditions (1.02 mL/dL blood plasma), breathing with 52.6% oxygen is necessary. However, more than 52.6% oxygen is essential when using an oxygen mask, because high concentrated oxygen, which flows from an oxygen concentrator to the oxygen mask, mixes with the carbon dioxide expelled through expiration and lower the oxygen concentration within the small, confined space of the oxygen mask. Furthermore, flow from the oxygen concentrator to the oxygen mask influences breathable oxygen concentration; low flow from the oxygen concentrator decreases oxygen concentration in the oxygen mask.

To obtain the similar content of dissolved oxygen (1.02 mL/dL blood plasma), which is achieved with exposure to mild hyperbaric oxygen, with the oxygen mask under normobaric conditions, approximately 90% oxygen at 12 L/min from the oxygen concentrator to the oxygen mask is needed (unpublished observation). If it is not necessary to increase atmospheric pressure, an expensive device to maintain high atmospheric pressure is not required. If any trouble occurs when using the oxygen mask, we can immediately interrupt the high-oxygen condition. Provided that there are an oxygen concentrator and an oxygen mask, we can maintain high oxygen concentration anywhere. Furthermore, there is no risk of barotrauma under normobaric conditions.

Breathing with highly concentrated oxygen with the oxygen mask under normobaric conditions is expected to obtain the content of dissolved oxygen at similar levels. Therefore, we expect to obtain the same effects observed by exposure to mild hyperbaric oxygen, as suggested by Dr. Andel. I examine oxygenation under normobaric conditions with different oxygen concentrations and flow quantity to obtain the most suitable effect and to investigate the incidence of side effects.

References

1. Nagatomo F, Fujino H, Kondo H, Ishihara A (2012) Oxygen concentration-dependent oxidative stress levels in rats. Oxid Med Cell Longev. https://doi.org/10.1155/2012/381763

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2. Ishihara A (2019) Mild hyperbaric oxygen: mechanisms and effects. J Physiol Sci 69:573–580