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Alveolar Hemorrhaging After Free Diving

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Abstract: A 36-year-old woman performed a 20-m free dive with fins. She felt dyspnea and developed a cough after the fourth free dive. She grew pale, so an ambulance was called. When emergency medical technicians checked the patient, the percutaneous saturation of oxygen was approximately 70%, so she received 10 L/minute of oxygen with a reservoir face mask. She also had hemoptysis. On arrival at our hospital, chest roentgen revealed bilateral cloudy lung fields. The findings on an electrocardiogram were negative. Cardiac ultrasound findings showed a good wall motion and were negative for gas. Thoracic computed tomography (CT) revealed a bilateral diffuse ground-glass appearance. She was admitted to the hospital with oxygen therapy, and her respiratory function dramatically improved. On the third day, she was discharged without sequalae. This is a rare case report showing alveolar hemorrhaging after free diving. The differential diagnosis with decompression sickness may be facilitated by a thorough review of the diving profile and an investigation of the gas bubbles using ultrasound. Physicians may encounter patients with pulmonary barotrauma regardless of practice location and should be familiar with its clinical manifestations and treatment.
Key words: barotrauma; free diving; alveolar hemorrhage.

INTRODUCTION

Based on Boyle's law, the relative volume change from 2 to 3 atmospheres absolute (ATA) is less than the change from 1 to 2 ATA; therefore, for a given change in depth, the gas volume change is greater when closer to the surface. Barotrauma can occur on descent or ascent. With increased pressure during descent, the gas volume in air-containing body cavities, such as the lungs, middle ear, paranasal sinuses, and gastrointestinal tract, is diminished [1]. If the pressure in these spaces does not equalize with the ambient pressure, tissue injury results from the forces generated by the pressure difference between the ambient pressure and the body cavity. Barotrauma can also involve a diving mask and air pockets associated with teeth [1].

We herein report a case of pulmonary barotrauma induced by free diving.

CASE REPORT

A 36-year-old woman performed a 20-m free dive with fins. She felt dyspnea and developed a cough after the fourth free dive. She grew pale, so an ambulance was called. Her personal and family history was unremarkable. When emergency medical technicians checked the patient, the percutaneous saturation of oxygen was approximately 70%, so she received 10 L/minute of oxygen with a reservoir face mask. She had also hemoptysis. On arrival at our hospital, her vital signs were as follows: blood pressure, 102/54 mmHg; heart rate, 92 rate/minute; respiratory rate, 30 breath/minute; and percutaneous oxygen saturation 98% breathing 10 L/min oxygen. Chest roentgen revealed bilateral cloudy lung fields. The findings on an electrocardiogram were negative. Cardiac ultrasound findings showed a good wall motion and were negative for gas. An arterial gas analysis revealed a pH of 7.395, PCO_2 of 37.8 mmHg, PO_2 of 98.6 mmHg, HCO_3^- of 22.6 mmol/l, and a base excess level of -1.4 mmol/L. The results of a biochemical analysis of the blood were not specific. Thoracic computed tomography (CT) revealed a bilateral diffuse ground-glass appearance (Figure 1). She was admitted to the hospital with oxygen therapy. On the second day, her respiratory function had dramatically improved. On the third day, her percutaneous saturation of oxygen increased to 98% under room air. The thoracic CT findings became normal (Figure 1). She was discharged the same day without sequalae.

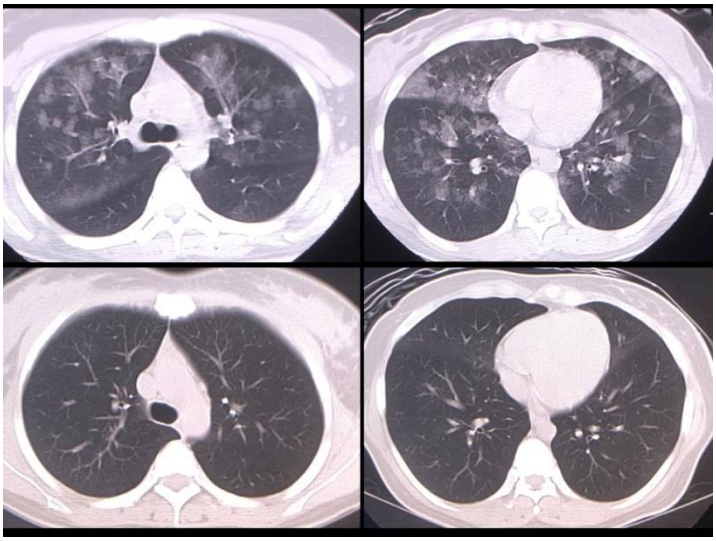

Fig-1: Thoracic computed tomography (upper, on arrival; lower, the third hospital day). Thoracic CT on arrival showed a bilateral ground-glass appearance in the lung fields. On the third day, the findings in the lung fields became normal

DISCUSSION

This is a rare case report showing alveolar hemorrhaging after free diving. During breath-hold diving, air in the lungs is compressed by increasing the ambient pressure according to Boyle's law. After descending below a "squeeze" depth, at which alveoli are compressed to their smallest noncollapsible volume, the blood pressure in the pulmonary capillaries exceeds the intra-alveolar pressure [2-4]. The increased transpulmonary capillary wall pressure leads to "stress failure" of pulmonary capillaries, resulting in leakage of fluid and blood into the lungs, i.e. pulmonary edema and even hemorrhaging [2-4]. During a rapid ascent in scuba diving, increased gas volume in a confined space can produce tissue disruption and rupture, which may lead to pulmonary barotrauma, manifesting as pneumothorax, pneumomediastinum, subcutaneous emphysema, arterial gas embolism, etc. [2-4]. Because our patient had dived to 20-m-deep and surfaced rapidly, barotrauma arising from the rapid ascent was the most likely mechanism inducing alveolar hemorrhaging.

Generally, pulmonary edema or hemorrhaging is treated supportively [5]. Recompression treatment is not indicated for barotrauma except for in cases of gas embolization. The differential diagnosis with decompression sickness may be facilitated by a thorough review of the diving profile and an investigation of the gas bubbles using ultrasound [6]. However, if differentiation is difficult, recompression treatment may be indicated [7].

This case fortunately improved with only oxygen therapy. Given that breath-hold diving with empty lungs to shallow depths can induce hemoptysis in healthy subjects, physicians may encounter patients with pulmonary barotrauma regardless of practice location and should be familiar with its clinical manifestations and treatment [8].

CONCLUSION

We herein report a rare case of alveolar hemorrhaging after free diving. Physicians may encounter patients with pulmonary barotrauma regardless of practice location and should be familiar with its clinical manifestations and treatment.

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