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Type II Decompression Illness after Diving Seven Meters

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Abstract A 30-year-old man went occupational diving 2 times. The first was a 20-min dive at a depth of 3.3 m, and the second was a 10-min dive at a depth of 7.7 m. During the second dive, he felt chest pain and suddenly surfaced. After reaching the surface, he felt dyspnea and headache. He also felt dysesthesia in every extremity during transportation. Upon arrival, he was in hypertensive bradycardia state. A physical study demonstrated no remarkable findings except for his complaints. His electrocardiogram, chest roentgen, whole-body computed tomography, and blood test findings were negative. He was diagnosed with decompression illness (DCI) and transported to another hospital for hyperbaric oxygen therapy. During his transfer, he showed quadriparesis, which was compatible with decompression sickness type II. He was treated as outlined in United States Navy Treatment Table 6. He ultimately obtained a complete recovery and was reinstated. We reported a concrete case of DCI after a shallow dive. DCI should be strongly considered when divers report feeling unwell after diving.

Keywords: *decompression illness, diagnosis, shallow water*

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1. Introduction

Decompression illness (DCI) is caused by the formation of bubbles of gas that occur with changes in pressure during scuba diving. [1,2] It includes two pathophysiological syndromes: arterial gas embolism (AGE) and the more common decompression sickness (DCS). Clinically, AGE and DCS are difficult to discern, so the definition of DCI is applied to both cases. [3]

AGE occurs when expanding gas stretches and ruptures alveolar capillaries—pulmonary barotrauma—allowing alveolar gas to enter the arterial circulation. This syndrome can occur after ascent from a depth as shallow as 1 m if the starting lung volume is close to total lung capacity. [2,4] Concerning DCS, nitrogen or any gas from a diver's air tank increases in pressure as a diver descends. For every 10.0 meters (m) in ocean water, the pressure due to nitrogen goes up another 0.79 atmospheres. As the pressure due to nitrogen increases, more nitrogen dissolves into the tissues. The longer a diver remains at depth, the more nitrogen dissolves. The risk of DCS is thus directly related to the depth of the dive, the amount of time under pressure, and the rate of ascent. [1,2]

Dive tables, such as the U.S. Navy Dive Tables, provide general guidelines as to what depths and dive times carry less of a risk for the development of DCS. Based on the diving table, diving under 10 m does not require a decompression stop during ascent. This means there is no limit to the maximum allowable dive time when diving under 10 m. However, divers can develop DCI on very short dives or in shallow water, even when adhering to protocols. [4] DCI should therefore be strongly considered when divers experience pain after diving. Any neurologic symptoms after a dive are abnormal and should be attributed to DCI. Even doubtful cases should be treated immediately with hyperbaric oxygen (HBO).

We herein report a case of Type II DCI after a dive of seven meters. [2]

2. Case Presentation

A 30-year-old man went occupational diving 2 times. The first was a 20-min dive at a depth of 3.3 m, and the second was a 10-min dive at a depth of 7.7 m. During the second dive, he felt chest pain and suddenly surfaced. After reaching the surface, he felt dyspnea and headache in addition to chest pain. He was transported to our hospital by an ambulance. He felt dysesthesia in every extremity during transportation. He had no remarkable personal or family history.

Upon arrival, his vital signs were as follows: Glasgow Coma Scale, E4V5M6; blood pressure, 156/68 mmHg; pulse rate, 46 beats per minute; respiratory rate, 20 breaths per minute; and body temperature, 36.9°C. A physical study demonstrated no remarkable findings except for his complaints. An arterial blood gas analysis under 10 L per

minute of oxygen mask revealed pH, 7.530; PO_2, 289 mmHg; PCO_2, 29.7 mmHg; HCO_3^-, 24.7 mmol/L, base excess 3.1 mmol/L. His electrocardiogram, chest roentgen, and whole-body computed tomography findings were negative. The results of a blood test are shown in Table 1.

He was diagnosed with DCI and transported to another hospital for HBO therapy using a multiplace chamber. During his transfer, he showed quadriparesis, which was compatible with DCS type II. [2] He underwent repeated HBO as outlined in United States Navy Treatment Table 6. He ultimately obtained a complete recovery and was reinstated.

Table 1. Results of a biochemical analysis of a blood sample obtained on arrival

Variable	level	unit
White blood cell count	6600	/μL
Hemoglobin	14.8	g/dL
Platelets	24.8 x 104	/μL
Total protein	7.9	g/dL
Albumin	3.4	g/dL
Total bilirubin	0.8	mg/dL
Aspartate aminotransferase	22	IU/L
Alanine aminotransferase	17	IU/L
Lactate dehydrogenase	204	IU/L
Alkaline phosphatase	175	IU/L
Glutamyl transpeptidase	14	IU/L
Creatine kinase	351	IU/L
Blood urea nitrogen	11.8	mg/dL
Creatinine	0.83	mg/dL
Sodium	142	mEq/L
Potassium	4.4	mEq/L
Chloride	103	mEq/L
Calcium	9.7	mg/dL
C reactive protein	0.3	mg/dL
Prothrombin time-international normalized ratio	0.99	
Activated partial thromboplastin time	32.4(27.1)	Second
D-dimmer	0.5	μg/mL
Brain natriuretic peptide	14.2	pg/mL

3. Discussion

There have been reports suggesting that DCI can develop even in shallow water (within 10 m). [5,6] However, few medical reports have described concrete cases. Hadanny et al. reported that a 22-year-old diver visited the hospital due to headaches and left-side numbness 3 days after diving to a depth of 6 m for 25 min. [7] Fluid-attenuated inversion recovery brain magnetic resonance imaging revealed diffuse meningeal enhancement by contrast medium. Brockhattingen et al. also reported that a 38-year-old obese male recreational diver stayed at a depth of 3 m for approximately 1 h. [8] He then rapidly ascended, and his symptoms began, ultimately requiring HBO for treatment. In addition, three cases clinically classified as AGE have been reported, indicating that even dives as shallow as 1 m can result in DCI. [9,10,11]

Circulating venous bubbles after shallow dives can also lead to DCI. Geyer et al. reported that 28 children and adolescents performed two 25-min dives to a depth of 10 m with a 90-min surface interval. [12] After diving, bubbles were observed by ultrasound in a total of six subjects, but none of them showed any symptoms of DCI. Ikeda et al. also reported dives to depths of 6, 7, and 8 m over 3 days. [13] Ten subjects showed compression after diving to 6 and 7 m, and 9 showed compression after diving to 8 m. One bubble streak was shown in the 6-m-dive group. A small number of bubbles were seen in four subjects in the 7-m-dive group. All subjects in the 8-m-dive group presented with various amounts of bubbles. DCI was not observed in the 6- or 7-m-dive groups, but in the 8-m-dive group, 4 subjects suffered from DCI and required HBO. The authors concluded that the minimum depth for detectable bubble formation was around 6 m, and a direct ascent from saturation at 8 m seems to carry a high risk of DCI. Accordingly, based on precious reports, diving to a depth of 7.7 m, as in the present case, can result in DCI.

4. Conclusion

We described a concrete case of a patient who developed DCI after a shallow dive. DCI should be strongly considered when divers report feeling unwell after diving.

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