

HYPERBARIC OXYGEN THERAPY IN SEVERE DECOMPRESSION SICKNESS: CLINICAL CASE

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ABSTRACT

The authors analyzed a case of severe decompression syndrome with signs of neurological-marrow compromise, which occurred a half-hour after an underwater dive that didn't respect the rules of safe diving. The patient was treated by hyperbaric oxygen therapy according to U.S. Navy Table 6, with subsequent maintenance cycles, which improved the patient's condition and cured the neurological symptoms

Key words: hyperbaric oxygen therapy, decompression sickness, scuba underwater diving, hyper pressure gas, barotrauma.

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Introduction

Decompression sickness (DCS) is a pathology characterized by insufficient elimination of inert gas nitrogen and consequent formation of bubbles in the blood stream and other tissues. DS may occur following an underwater dive or other prolonged exposure to high pressure. In some sensitive subjects decompression sickness may also occur following a dive within the so-called safety zone (ratio of immersion time to depth), which in normal divers prevents the accumulation of excessive nitrogen in the body. There are several factors that provoke an excessive absorption of inert gas, and depend on the fitness of the diver and prior training, stress and fatigue, and the external environment, e.g. extreme water temperature⁽¹⁾. Each occurrence of (DCS) requires decompression treatment of different types depending on the severity of the clinical condition. The symptoms vary according to the tissue affected. Mild forms are commonly characterized by feeling ill, prostration, and widespread itching, which is difficult to diagnose. Severe forms are characterized by joint pain, reduced sensation, muscular paralysis, pulmonary hyper pressure with interstitial emphysema, and gas

embolism in the CNS with behavior disturbances and other neurological signs⁽²⁾.

Material and methods

In November 2013 a Caucasian male aged 32, height 170cm, weight 68kg, was admitted to our Emergency Room with mild chest pain that improved on deep breathing. He had no history of neurological illness, but a half hour before admission he had dived underwater without respecting the rules of ascent. Approximately 15 minutes after the pain began the patient also experienced paresthesia in the lower limbs, progressive weakness, and finally difficulty moving. Considering the improper dive prior to the symptoms, we decided on treatment in a decompression chamber using hyperbaric oxygen therapy: U.S. Navy Table 6⁽³⁾. After treatment the patient appeared to be in good clinical condition with no neurological signs. Six hours later, however, the paresthesia in the lower limbs reappeared, so a second cycle of treatment in the decompression chamber followed, after which the patient's condition worsened significantly. The patient was then treated with 5 hyperbaric oxygen cycles per week for a total

of 40 cycles. At the end of the treatment the patient's condition improved and the paresthesia disappeared.

Results

Considering the circumstances and dynamics of the dive and subsequent symptoms, the patient underwent decompression treatment using U.S. Navy Table 6 Standard (Table 1), repeated after a few hours of the reappearance of neurological symptoms. In the first phase of treatment the aim was to mechanically and chemically reduce the volume of the bubbles.

Depth (meters)	Time (minutes)	Gas
18 m	20 m	Oxygen 100%
	5 m	Air
	20 m	Oxygen 100%
	5 m	Air
	20 m	Oxygen 100%
	5 m	Air
18 m - 9 m	30 m	Oxygen 100%
9 m	15 m	Air
	60 m	Oxygen 100%
	15 m	Air
	60 m	Oxygen 100%
9 m - surface	30 m	Oxygen 100%

Table 1: US Navy Table 6 Standard.

Depth (meters)	Time (minutes)	Gas
15 m	30 m	Oxygen 100%
	5 m	Air
	30 m	Oxygen 100%
15 m - surface	15 m	Oxygen 100%

Table 2: Treatment plan for daily hyperbaric oxygen therapy.

Considering the neurological symptoms, daily treatment using hyperbaric oxygen therapy (Table 2) was performed until the clinical picture stabilized.

Discussion

Identifying individual risk factors can minimize the probability of this pathology, namely: obesity, lack of training, dehydration, previous decompression sickness, the presence of patent foramen oval⁽⁵⁾, and technical predisposing factors such as the choice

of a conservative time/depth table, the proper speed of ascent, pauses according to the decompression table, avoiding repeated or prolonged dives and excessive depth, cold water temperature, have maximum surface time between dives, follow proper dive protocols, having minimum effort stress during dives, and using the Valsalva maneuver after the dive. Neurological-marrow treatment of decompression sickness requires immediate hyperbaric oxygen therapy, because after 2-4 hours the effectiveness of the treatment declines, especially in serious cases⁽⁴⁾.

Conclusion

A diver who doesn't respect the rules of safe diving risks a series of problems that vary according to the tissue affected. In mild cases there is a feeling of ill ease, prostration and widespread itching. In more severe cases there may be joint pain, reduced sensitivity, muscular paralysis, and pulmonary hyper pressure with interstitial emphysema and gas embolism in the SNC with behavior disturbances and local neurological symptoms. Currently the only treatment that can cure the patient's symptoms is hyperbaric oxygen therapy: U.S. Navy Table 6⁽³⁾, and HBOT cycles. Treatment must also be characterized by caution in using positive pressure ventilation, since it can provoke more bubbles and a worsening of the patient's condition⁽⁵⁾.

References

- 1) Marroni A, *Patologia da decompressione, una valutazione alla luce delle più recenti acquisizioni*, Dan Europe, 2010.
- 2) Denoble P, Vann RD et al, *Project dive safety, medical aspects*, Undersea Hyperbaric Med, 1995; 22 (suppl): 88.
- 3) *Manuale d'immersione-US Navy diving manual*, Edizione Italiana, GSE Trieste-2010.
- 4) Weenink RP, Hollmann MW, Vrijdag XC, Van Lienden KP, De Boo DW, Stevens MF, Van Gulik TM, Van Hulst RA., "Hyperbaric oxygen does not improve cerebral function when started 2 or 4 hours after cerebral arterial gas embolism in swine", Crit Care Med. 2013 Jul; 41(7): 1719-27.
- 5) Torti S.R., Billinger M., Schwerzmann M. Eur Heart J.: Risk of decompression illness among 230 divers in relation to presence and size of patent foramen ovale. Eur Heart J. 2004 Jun; 25(12): 1014-20.

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