

Management of decompression sickness in Jordan

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معالجة داء الغوص في الأردن جميل محمد الرفاعي

خلاصة: أجريت هذه الدراسة في قسم طب الأعماق بمستشفى الأميرة هيا الحسين، حيث تم فحص 23 حالة (22 من الذكور وأنثى واحدة)، كان تشخيصهم داء الغوص من النمطين الأول والثاني، وعولجوا في غرفة مفرطة الضغط. وأظهرت النتائج أن 61% من حوادث الغوص كانت إصابات بداء الغوص من النمط الثاني، وأن 26% ممن عولجوا ظلت لديهم بعض الأعراض بعد الجلسة الأولى من معالجة استرجاع الضغط، وأن 74% منهم قد شفوا تماماً. ولم تحدث وفيات بين المصابين، كما لم تشاهد أية مصاعفات. وننتهي الدراسة إلى أن داء الغوص من النمط الثاني هو النوع الأكثر شيوعاً، ويشاهد غالباً بين ممارسي رياضة الغوص. إن ملاحظة الأعراض وبدء المعالجة في وقت مبكر، سوف تؤدي إلى نتائج أفضل بكثير.

ABSTRACT This study, conducted at Princess Haya Hussein Hospital Hyperbaric Department, examined 23 cases (22 males, 1 female), diagnosed with decompression sickness (types I and II) and treated with hyperbaric therapy. The results showed 61% of dive accidents were decompression sickness type II; 26% of treated patients had residual symptoms after the first session of recompression treatment and 74% made a full recovery. There were no deaths and no complications were observed. The study concludes that decompression sickness type II is the most common type, found mainly in sports divers. Early recognition of symptoms and commencement of treatment lead to a much better outcome.

La prise en charge de la maladie de la décompression en Jordanie

RESUME Durant cette étude qui a été réalisée au service de médecine hyperbare de l'Hôpital Princesse Haya Hussein, on a procédé à l'examen de 23 cas (22 hommes, 1 femme) chez lesquels la maladie de la décompression (types I et II) avait été diagnostiquée et traitée par thérapie hyperbare. Les résultats ont montré que 61% des accidents de plongée concernaient la maladie de la décompression de type II; 26% des patients traités ont eu des symptômes résiduels après la première séance de recompression thérapeutique et 74% se sont tout à fait rétablis. Il n'y a pas eu de décès et aucune complication n'a été observée. Les conclusions de l'étude sont que la maladie de la décompression de type II est la plus courante, rencontrée principalement chez les plongeurs sportifs. La reconnaissance des symptômes et la mise en route du traitement à un stade précoce permettent une bien meilleure issue.

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Introduction

On the earth's surface, the human body is exposed to an ambient pressure, which is the result of the combined partial pressures of all the gases in the earth's atmosphere. At sea level, the force of this pressure is described as one atmosphere absolute (ATA). As a diver descends, exposure to increasing pressure causes more gas to dissolve in the bodily fluids and tissues, as described by natural gas laws. Upon ascent through the water column, the solubility decreases again. Rapid ascent may lead to bubble formation and decompression sickness (DCS). Recreational scuba diving is the most common type of hyperbaric exposure, especially since its tremendous growth as a sport in the past decade. Because of the increasing popularity of recreational scuba diving, primary care physicians should be familiar with common diving injuries [1].

Hyperbaric oxygen (HBO) treatment is gaining popularity as the definitive therapy for a growing number of disorders, including DCS, arterial gas embolism (AGE), carbon monoxide poisoning, clostridial infections, crush injuries, diabetic leg ulcers, skin graft failures, refractory osteomyelitis, thermal burns, necrotizing soft tissue infections and osteoradionecrosis [2].

DCS is a disease of nitrogen bubble formation [3]. It occurs when gas previously dissolved in body fluids under pressure forms bubbles or layers of gas in the tissues or bloodstream when pressure is reduced. It can result from a diver staying too long at a depth and saturating the tissues with nitrogen, or it can occur even with a perfectly normal dive where the diver has followed decompression tables [3].

DCS can be divided into two categories depending on symptoms.

- Type I DCS (simple) has the following systemic manifestations: joint pain (the bends), which is the most common complaint in DCS, with pain in the elbow, shoulder, hip and knee joints [4-6]. The skin may be involved, displaying a mottled appearance known as cutis marmorata. Bubbles in the lymphatic system may result in regional lymphoedema.
- Type II DCS (severe) may involve the brain, the spinal cord, the joints or the cardiopulmonary system [7]. Neurologic manifestations may include sensory impairment, hemiplegia, paraplegia, paresthesias and peripheral neuropathies [8]. Possible pulmonary and cardiopulmonary effects include massive pulmonary gas emboli or myocardial infarction.

Repetitive and multiday diving practices are common in all diving communities. Recreational diving accident data suggest that multiple dives have a greater incidence of DCS than single dives [4].

Factors influencing DCS are: physical fitness, old age in females, dehydration, alcohol intake, adaptation, water temperature, obesity, increased carbon dioxide pressure, physical injury, altitude exposure and dive profile (rapid and multiple ascent, repetitive and multiday diving) [9].

The aim of this study was to examine cases diagnosed with and treated for DCS. Neurological and clinical examinations were performed before, during and after treatment in all patients. Age, diving certificate, risk factors, time of first symptom, type of DCS, treatment table used and the result of the first session of treatment were recorded.

Patients and methods

The setting was the Hyperbaric Department of the Princess Haya Hussein Hospital, Aqaba. The hospital serves principally military personnel and their dependents; however, it provides services for other citizens (including expatriates) if needed. The study covers all patients recorded in the Hyperbaric Department diagnosed with DCS, over the 4-year period 1 January 1994 to 31 December 1997. A total of 23 patients (22 males, 1 female), age range 14–57 years, were included.

Treatment was carried out in the multi-place double lock chamber (Drager type, Germany). The main (inner lock) chamber can take up to six people, or one supine and three in sitting position. The daughter (outer lock) chamber can take one person, for the purpose of changing the inside observer (nurse), or moving medical equipment inside or outside the main chamber. The patients are supplied with pure oxygen by aviator-fit face masks, one mask for each occupant. The oxygen is supplied from two banks of pure (98.4%) oxygen cylinders, each of 5 m³ volume. The air is supplied

from two air banks (in turn supplied from two air compressors). Each air bank has cylinders of 7 m³ volume, necessary to keep the inside gases within normal limits; the oxygen limit inside the chamber should not exceed 24% and the carbon dioxide limit is up to 0.5% surface equivalent partial pressure. The inside observer (nurse) takes the oxygen reading according to the United States (US) Navy standards. All patients tolerated the chamber and no history of claustrophobia was recorded, as all divers were familiar with hyperbaric chambers.

All patients had a re-evaluation at least once for their symptoms during therapy inside the chamber, either by the nurse (the inside observer), or by the diving medical officer. Usually the medical examinations were carried out according to the symptoms, primarily the neurological deficits.

Results

Table 1 shows the relation of the type of DCS to age and the most common risk factors.

Table 1 Relation of DCS and age group with the main risk factors

Variable	DCS I		DCS II		Statistical significance
	No.	%	No.	%	
Male	14	60.87	8	34.78	Mainly multiday, level, dive
Female	0	0	1	4.35	
Total	14	60.87	9	39.13	Flying after diving
Age (years)					
11–20	0	0	1	4.35	Altitude after diving
21–30	11	47.83	2	8.70	Rapid ascent
31–40	2	8.70	2	8.70	Loss of buoyancy
41–50	1	4.35	3	13.04	Dehydration
51–60	0	0	1	4.35	Dehydration

DCS = decompression sickness

es than previous reports, with 81% of patients experiencing DCS II [16].

Conclusion

This study emphasizes the need to make divers more aware of diving accidents, the

risk factors and how problems can be avoided. Physicians need to recognize the signs and symptoms of DCS and to apply treatment more rapidly in order to reduce morbidity and mortality. Safe diving means a lower incidence of DCS, but good diving experience does not guarantee that accidents will not occur.

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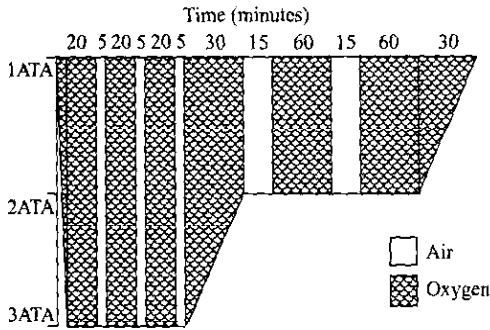
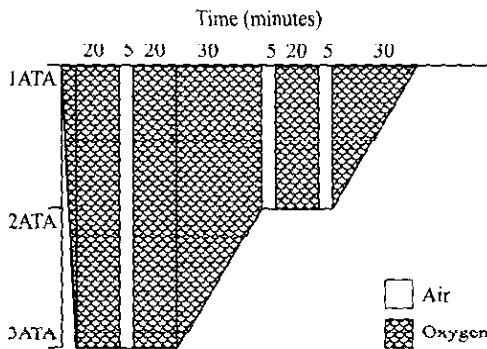


Table can be extended at 3ATA one or two other cycles, and at 2ATA one or two cycles depending on the progression of the symptoms.
 Descent rate = 25 feet/minute
 Ascent rate = 1 foot/minute
 Total elapsed time = 4 hours 45 minutes
 Can be extended to = 8 hours 05 minutes

Figure 4 US Navy Treatment Table 6



Descent rate = 25 feet/minute
 Ascent rate = 1 foot/minute
 Total elapsed time = 2 hours and 15 minutes

Figure 5 US Navy Treatment Table 5

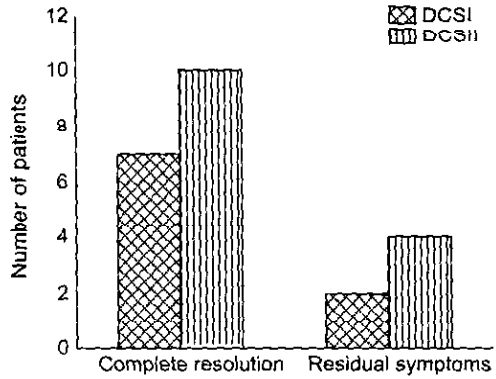


Figure 6 Results of treatment after the first session

the majority of patients because most of them were foreigners living outside Jordan.

Discussion

This is the second study conducted in Jordan to include data of diving diseases. A previous study which analysed 5 cases of diving diseases treated in the same hyperbaric centre was conducted by Zureikat [10]. The present study found that 14 patients (60.87%) had DCS II and 9 (39.13%) had DCS I (Table 1). The study conducted by Kizer on a series of 50 cases, noted 24 patients (48%) with DCS I and 26 (52%) with DCS II [11]. Thalmann and colleagues reported that even relatively risky experimental dive series conducted by the US Navy to develop new decompression tables and decompression computer programs had a predominance of DCS I symptoms [106 cases (74%) of DCS I compared with 37 cases (26%) of DCS II] [12-15]. In contrast to this, recreational sports have a higher incidence of more serious symptoms. However, diving fishermen in Singapore, with a significant delay in recompression, had a much higher incidence of serious cas-

es than previous reports, with 81% of patients experiencing DCS II [16].

Conclusion

This study emphasizes the need to make divers more aware of diving accidents, the

risk factors and how problems can be avoided. Physicians need to recognize the signs and symptoms of DCS and to apply treatment more rapidly in order to reduce morbidity and mortality. Safe diving means a lower incidence of DCS, but good diving experience does not guarantee that accidents will not occur.

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