Case reports

Respiratory decompression sickness in a recreational scuba diver

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Decompression illness, decompression sickness, respiratory, cardiovascular, case reports

Abstract

(Wilson CM, Sayer MDJ. Respiratory decompression sickness in a recreational scuba diver. *SPUMS J*. 2005; 35: 206-8.) A case study is presented relating to the treatment of a recreational diver with suspected respiratory decompression sickness. The diver had performed a rapid ascent after running out of air at a depth of 15 metres and had immediately displayed all of the classic symptoms of respiratory decompression sickness, with severe chest pain, 'bubbling' in the chest, progression to pain on inspiration, development of a dry cough, blood in the sputum and development of dyspnoea. Eventual treatment was successful with complete resolution. However, the time from surfacing to treatment was almost 13 hours following difficulties in transferring the diver from a remote location. In this case, there was some reduction in the severity of the symptoms during transfer to a recompression facility with the delivery of normobaric oxygen and aggressive hydration.

Introduction

Respiratory decompression sickness has been well documented over the years both in diving and aviation medicine. Historically, this manifestation of decompression is known as 'the chokes'; other terms are pulmonary or cardiopulmonary decompression sickness and cardiorespiratory decompression sickness.[1–3] It is one of the rarer presentations of decompression sickness, having only 2.0% prevalence in 11,471 manifestations compiled from DAN data.[2]

Accounts of actual cases of respiratory decompression sickness are rare in the literature. The present report describes a case that was treated in 1996 at the Dunstaffnage Hyperbaric Unit near Oban on the west coast of Scotland. It also details the problems associated with patient transfer from remote locations.

Case report

A 60-year-old male recreational scuba diver was diving from the Island of Islay in the Inner Hebrides off the west coast of Scotland. Islay is renowned for its many and varied distilleries producing malt whiskies of great character.[4] He was not an experienced diver having been diving for only four years. He had a long-standing medical history of hypertension for which he was being adequately controlled with the angiotensin converting enzyme (ACE) inhibitor drug, enalapril 5 mg daily.

During his time in Islay he and his dive buddy, who was a doctor, had been diving to between 12 and 19 metres carrying out a total of six dives over a three-day period. His incident dive, the second of the day, was commenced at 1700 hr to 15 metres' sea water remaining there for 31 minutes. He unfortunately ran out of air at this point and made a rapid ascent which was uncontrolled during the last six metres to the surface. He immediately experienced severe anterior chest pain, pain in the back of the neck that radiated into the head described as being similar to a migraine and felt his thinking was lacking clarity. Within a few minutes of surfacing he described a "bubbling" feeling in his chest, which progressed to pain on inspiration. A cough developed and blood was noted in his sputum. He then became dyspnoeic and after a short time had difficulty in walking short distances.

It was felt that he required medical assistance and was taken at 1930 hr (*circa* two hours post dive) to the cottage hospital on Islay. Cottage hospitals in Scotland are in remote areas of sparse population and are run by the local general practitioners (GPs). At this point he could not walk the length of his trolley because of his dyspnoea and was noted to be hypoxic with a SpO_2 of 85% on air. A chest X-ray and electrocardiogram (ECG) appeared normal and he was commenced on oxygen, 4 $l.min^{-1}$ by Hudson mask.

Doctors in remote areas where diving is uncommon may have little or no working knowledge of diving problems but Scotland has an emergency telephone support service run from Aberdeen Royal Infirmary, where the UK National Health Service (NHS) has the only funded hyperbaric service in the British Isles. The advice from the consultant on call in Aberdeen was that this was very likely to be a diving-related problem and the patient should have high-flow oxygen, fluid resuscitation and be transferred to a recompression facility for urgent assessment and appropriate

further management. The GP was requiring a great deal of persuasion to transfer the casualty but eventually organised a helicopter transfer by Search and Rescue (SAR) flight of the Royal Navy.[5]

The UK has a number of SAR bases around its coastline and in this case a helicopter was despatched from its base at Prestwick, just south of Glasgow, with the intention of transferring the diver from Islay (about 120 miles northwest of Prestwick) to the nearest recompression facility at Oban (about 50 miles north of Islay). At 2200 hr the helicopter was nearing the vicinity of Islay when it encountered heavy and persistent fog and visibility was so low as to make landing impossible. In the course of deciding on the next course of action the helicopter received notice of another medical emergency and so, as landing was not possible at Islay, the helicopter was redeployed elsewhere.

With the helicopter's departure, the GP decided to keep the patient on Islay. It took a great deal of time and persuasion by phone for the Aberdeen consultant to convince the GP that the diver did need to be transferred to an appropriate treatment facility at the earliest opportunity. It was eventually arranged for the 50-mile journey to be carried out by Royal National Lifeboat Institution (RNLI) lifeboat.[6] RNLI lifeboats in the UK are provided by charitable donations and are crewed by highly trained volunteers.

At 0100 hr the next day (over seven hours post dive) the Islay lifeboat left Islay with the GP and patient on board and began to travel north, while the RNLI lifeboat at Oban also launched to travel south. The Oban lifeboat carried a doctor with diving medical expertise and the intention was to rendezvous with the Islay lifeboat midway between Islay and Oban thus reducing the time either boat was off station. After transferring the patient to the Oban boat it was found that the initial expert management advice had not been followed by the GP in charge of him. He was changed from his 4 $l.min^{-1}$ flow of oxygen by Hudson mask to 100% by demand system, an intravenous access had to be established and an infusion with normal saline and aggressive fluid replacement commenced. Following this his dyspnoea improved over the remaining 90 minutes of the journey.

On arrival at the Oban Hospital at 0400 hr (over 10 hours post dive), the diver was still complaining of anterior chest discomfort but with less pain; he still had a severe cough. Full blood count, blood biochemistry, repeat chest X-ray and ECG were all performed and found to be normal.

Recompression was commenced at 0600 hr, some 12 plus hours post dive, on a Royal Navy treatment table 62 at the Dunstaffnage Hyperbaric Unit. The Unit is housed in the Dunstaffnage Marine Laboratory, hosted by the Scottish Association for Marine Science. The original recompression chamber at Dunstaffnage was installed in order to conduct scientific diving operations in compliance with the Diving at Work Regulations. However, subsequent installations have primarily been designed to provide a treatment service for the NHS as part of the recent Scottish Hyperbaric Registration Scheme.

The patient had complete resolution of his symptoms after two oxygen cycles at 18 metres. The table was continued without modification and he surfaced at 1045 hr. On surfacing he felt completely normal. He had no dyspnoea and was able to run up and down the hospital stairs. He had no chest pain and his cough had completely settled. A repeat chest X-ray and ECG were normal. Biochemistry showed a raised creatine phosphokinase (CPK) but was otherwise normal. It is routine practice in Scotland to admit patients to hospital for at least 24 hours following treatment in order to monitor for relapse and to observe the quality of recovery. Following his 24 hours of post-treatment observation, the patient remained well and was discharged.

Discussion

Respiratory decompression sickness is characterised by the triad of substernal chest pain, paroxysmal cough and dyspnoea.[1,2,7,8] This diagnosis was made in this case though pulmonary barotrauma and gas embolism were considered. The initial symptoms experienced by the patient were classic of this form of decompression sickness with severe chest pain, "bubbling" in the chest, progression to pain on inspiration, development of a dry cough, blood in the sputum and development of dyspnoea. The depth and duration of the incident dive had not been especially provocative but there had been a rapid ascent following a cessation in air supply.

Traditionally, cardiopulmonary involvement has been described following dives with a severe decompression stress, either where the dive profiles were highly provocative with omitted decompression or where decompression was long and arduous.[1,2] This can cause large quantities of gas emboli to pass into the pulmonary filtering system and overload it resulting in right ventricular failure and circulatory collapse.[7] This clinical manifestation is seen when about 10% of the pulmonary vasculature is involved.[7] The time to onset of symptoms can vary from a short delay to one of several hours after surfacing.[1,2] In any case of respiratory decompression sickness the symptoms can persist and progress causing adult respiratory distress syndrome, disseminated intravascular coagulation, central cyanosis, respiratory acidosis, pulmonary hypertension and falling cardiac output.[2] Respiratory and/or cardiac arrest can follow if the patient is not recompressed as a matter of urgency.[2]

Respiratory decompression sickness represents one of the lethal forms of decompression illness and recompression treatment should be pursued with some urgency.[2,9] Because of the remoteness of the dive location and the problems experienced in evacuating the patient, time to treatment in this case was almost 13 hours. The early management of this condition should be with high-flow oxygen and fluid resuscitation, not differing from that of the other forms of

decompression sickness. It is unfortunate that the GP initially in charge of this case failed to follow the expert advice given to her, and was slow in progressing the urgent transfer despite great pressure from the Aberdeen consultant in telephone contact. The reason why this expert advice was not, or reluctantly, followed is unclear. However, there is no evidence of any progression in symptom intensity in this case during the delayed transfer and there was immediate improvement when the delivery of adequate normobaric oxygen and aggressive hydration was eventually instigated. In this case, recompression treatment consisted of a single unmodified Royal Navy table 62 with almost immediate and complete resolution.[10] Similarly good responses to treatment have been reported previously in cases of respiratory decompression sickness.[11] Although previous reports of respiratory or pulmonary decompression sickness had noted pulmonary oedema during lung scans,[3, 12] all chest X-rays in the presented case were normal. The potential severity of respiratory decompression sickness cannot be ignored. However, in this case an unavoidable delay to treatment did not appear to produce progressive deterioration of symptoms or influence the eventual degree of resolution.

At the time of this incident the Oban lifeboat was carrying 100% oxygen by-demand equipment for an evaluation trial. After the success of this trial the equipment was rolled out to all lifeboats both inshore and offshore. Also following this incident written advice in the initial management of diving-related problems listing appropriate telephone numbers was widely distributed to all hospitals in Scotland.

References

1 Flynn ET. Medical supervision of diving operations. In: Bove AA, editor. *Bove and Davis' diving medicine, 4th edition*. Philadelphia: Saunders; 2004. p. 343-79.

2 Francis TJR, Mitchell SJ. Manifestations of decompression disorders. In: Brubakk AO, Neuman TS, editors. *Bennett and Elliott's physiology and medicine of diving, 5th edition.* Edinburgh: Saunders; 2004. p. 578-99.

3 Moon RE. Treatment of decompression illness. In: Bove AA, editor. *Bove and Davis' diving medicine, 4th edition*. Philadelphia: Saunders; 2004. p. 195-223.

4 Jackson M. *Malt whisky companion, 5th edition*. London: Dorling Kindersley; 2004.

5 Royal Navy. [last accessed 13 Aug 2005]. Available from http://www.royal-navy.mod.uk/static/pages/content.php3?page=2865

6 The Royal National Lifeboat Institution. [last accessed 13 Aug 2005]. Available from http://www.rnli.org.uk

7 Walker R. Decompression sickness: clinical. In: Edmonds C, Lowry C, Pennefather J, Walker R, editors. *Diving and subaquatic medicine, 4th edition*. London: Arnold; 2002. p. 137-50.

8 Neuman TS. Arterial gas embolism and decompression sickness. *News Physiol Sci*. 2002; 17: 77-81.

9 Atkins CE, Lehner CE, Beck KA, Dubielzig RR, Nordheim EV, Lanphier EH. Experimental respiratory decompression sickness in sheep. *J Appl Physiol.* 1988; 65: 1163-71.

10 Royal Navy Medical Service. Report on the prevention and management of diving accidents. Institute of Naval Medicine; 2003. [last accessed 13 Aug 05]. Available from http://www.rnreference.mod.uk/09/inm/prevman/contents.htm

11 Gibbons JA, Ramsey CS, Wright JK, Pilmanis AA. Case history of serious altitude decompression sickness following rapid rate of ascent. *Aviat Space Environ Med*. 2003; 74: 675-8.

12 Radaideh MM, Lamki LM, Barron BJ, Elshazly SM. Radionuclide lung imaging in respiratory decompression sickness: potential role in the diagnosis and evaluation of hyperbaric therapy. *Clin Nuclear Med.* 2001; 26: 320-4.

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This case report was presented by Dr Wilson at the SPUMS Annual Scientific Meeting 2005 in The Maldives.

The database of randomised controlled trials in hyperbaric medicine maintained by Dr Michael Bennett and colleagues at the Prince of Wales Diving and Hyperbaric Medicine Unit is at:

<www.hboevidence.com>