Lesson of the month 1: A review of a diving emergency

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ABSTRACT

Physicians should consider barotrauma and decompression illness (DCI) in any patient presenting after a recent scuba dive, even apparently shallow dives. If and when DCI is suspected, clinicians should act without delay to transfer the patient to a recompression facility, even if diagnostic certainty has not been attained. We present a case of hyperbaric injury in an asthmatic woman who had an atypical presentation in view of the depth of dive.

KEYWORDS: Barotrauma, decompression illness, scuba diving

Case history

A 33-year-old woman was admitted to A&E having had an out-of-hospital cardiac arrest with immediate cardiopulmonary resuscitation (CPR) and restoration of spontaneous circulation (ROSC).

Handover from the ambulance crew stated she had been scuba diving at a depth of 7–10 m with a 'buddy' in a local lake. After approximately 6 minutes underwater, the patient signalled to her 'buddy' that she wished to ascend. She ascended rapidly from no more than 10 m, and more likely approximately 7 m. No further information was available as to whether she appeared unwell underwater, or whether she had held her breath during her ascent. At the surface she appeared extremely distressed and short of breath, but stated she had asthma and medication was available at her car and made a swim for shore. She swam approximately 50 m before showing signs of distress and lost consciousness, the patient was assisted to shore by the 'buddy'. On arrival to the lakeshore an off-duty paramedic performed immediate CPR, and ROSC was obtained after 2 cycles.

On arrival in A&E resus she was distressed and poorly responsive, moving all four limbs and had small but reactive pupils bilaterally. Glasgow coma scale was 6 in total (E1V2M3), with a low oxygen saturation level of 90% on air. Breath sounds were equal throughout the chest with no sign of a tension pneumothorax. Cardiac output appeared good, with normal blood pressure and sinus tachycardia on electrocardiogram (ECG). Temperature and blood glucose were within normal limits.

The patient was intubated and ventilated. Initial bloods were unremarkable, but arterial blood gases (ABG) showed type 1 respiratory failure. An urgent computerised tomography (CT) scan of her head and chest demonstrated cerebral oedema but no evidence of pneumothorax or pulmonary embolism. Following discussion with the team it was decided to contact the Diving Emergency Service to seek advice. They recommended urgent transfer of the patient to the nearest hyperbaric chamber; the patient was then flown by helicopter accompanied by an anaesthetic SpR and ITU nurse.

The patient subsequently suffered two further cardiac arrests, first on arrival at the receiving hospital which resulted in a successful resuscitation, the second arrest occurred before entering the hyperbaric chamber and unfortunately she could not be resuscitated and died. A post-mortem reported the cause of death as 'hyperbaric injury with cerebral oedema'.

Discussion

Scuba diving is a high-risk recreational activity. In 2013, there were 263 UK diving incidents reported, among them were 101 cases of decompression illness (DCI) and 14 fatalities.[1] DCI comprises the separate phenomena of arterial gas embolus (AGE, a form of barotrauma) and decompression sickness ('the bends'). It is a useful label, due to the similar management of the two conditions.[2]

Decompression sickness is caused by the formation of bubbles of inert gas coming out of solution in blood and tissues on depressurisation. They commonly materialise in the venous circulation, but can cross over to the arterial circulation via a right-to-left cardiac shunt, most commonly a patent foramen ovale. It often presents with numbness, joint and muscle pain, dizziness, fatigue, headache and weakness.[3]

Barotrauma occurs when ambient pressure changes cause expansion or contraction of gas within a closed body compartment. Common sites for such injury are the middle and inner ear, the sinuses and the lung. Less commonly it can affect the teeth, the stomach or the diving mask compartment.[4]

In the case of pulmonary barotrauma, outflow of expanding air can be limited by breath holding or obstructive pulmonary disease. This leads to alveolar rupture, allowing air to

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escape into surrounding tissues, causing pneumothorax, pneumomediastinum or subcutaneous emphysema. Air can also escape into the pulmonary veins, causing AGE. These emboli can occlude cerebral and cardiac blood flow and present as focal neurological defects, convulsions, coma and cardiac arrest. These clinical features may also be present in decompression sickness where gas bubbles have crossed to the arterial circulation.[5]

The management of DCI involves giving 100% oxygen, rehydration, keeping the patient supine to increase nitrogen washout and transferring to a decompression chamber for definitive management. If this transfer must take place by air, this should occur below 1,000 feet or within a pressurised cabin. Cardiopulmonary resuscitation should be performed if necessary.[2]

Hyperbaric injury was, in this case, initially felt unlikely due to the shallow depth of the dive, but even at a depth of 10 m, ambient pressure is increased to 1.97 atmospheres: almost double that at sea level. Underwater pressure increases linearly with diving depth, and as such, the largest change in lung volume occurs at shallower depths. It is even possible for an ascent from as little as 4 feet underwater to the surface to result in pulmonary barotrauma if the diver is holding their breath.[6] Diagnostic certainty is not required, and all divers with suspected DCI should have recompression treatment unless contraindicated; clearly, as tissue ischaemia is present, prompt treatment is a priority for better outcome, and the majority of patients with AGE fully recover with prompt recompression therapy.[7]

Learning points

- Do not rule out diving injuries even if the incident occurred at shallow depths.
- If you suspect decompression illness contact the nearest hyperbaric chamber urgently (locations can be found online at www.ukdiving.co.uk/information/hyperbaric.htm).
- Patients with asthma are more prone to barotrauma in view of their increased positive airway pressure. ■

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