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Case Report

Acute massive posterior stroke with tonsillar herniation in a scuba diver

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Abstract

A transient female passenger in her 40s presented to the emergency department (ED) exhibiting drowsiness post-scuba diving. Despite normal initial vitals, she reported dizziness, sleepiness, and occipital headache. A computed tomography (CT) scan showed a severe posterior circulation acute infarction affecting various brain regions, resulting in significant mass effects and complications like 4th ventricle compression, cerebellar tonsillar herniation, and hydrocephalus. Extensive diagnostic tests, blood workup, and stroke evaluations revealed normal findings, except for an incidental patent foramen ovale (PFO). Collaboration with neurosurgery led to her transfer for life-saving extraventricular drain (EVD) insertion and posterior fossa decompression. Treatment included right-side EVD insertion, suboccipital craniectomy, and foramen magnum decompression. Postoperatively, she was extubated the next day, alert, without focal neurological deficits. Upon EVD removal, a repeat CT head scan showed regression of mass effect. She was discharged home safely after 16 days, fully ambulating.

Keywords: scuba diving; stroke; emergency

Introduction

Scuba (self-contained underwater breathing apparatus) diving, an activity dating back to 1825 when William James introduced the first efficient full-time scuba apparatus, involves using a cylindrical belt around the diver's trunk, functioning as an air reservoir at 450 psi. The diver regulates the air supply by turning a valve on and off as required [1]. However, scuba diving exerts pressure differences on the cardiovascular system, leading to physiological changes such as bradycardia, alterations in left ventricular size, and pulmonary circulation, which may pose risks to the diver [2].

In this paper, we present an intriguing case of a previously healthy woman who suffered a massive stroke, with scuba diving being the sole identified risk factor. We will extensively discuss the potential risks of developing cerebrovascular accidents in individuals who participate in scuba diving.

Case report

A female transient passenger in her 40s was brought to the emergency department (ED) from the airport due to drowsiness. Upon arrival at the ED, the patient's initial vitals were normal; initially, the patient was not giving a full detailed history because of her drowsiness apart from feeling dizzy.

The neurological examination revealed no focal deficits or meningeal irritation signs. Subsequently, the patient underwent a computed tomography (CT) scan of the head to investigate the drowsiness and dizziness.

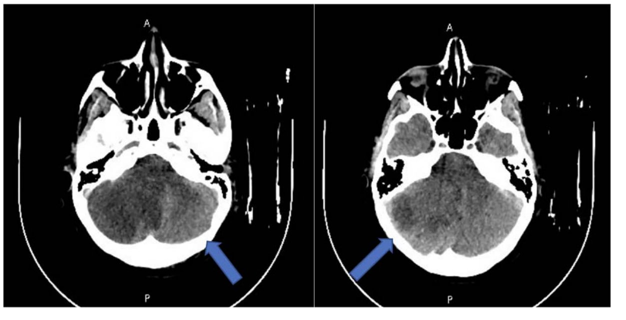

Figure 1. Arrows demonstrate bilateral cerebellar infarction.

The CT head revealed an extensive posterior circulation acute infarction. The infarction involved most of the right cerebellar hemisphere, with the superior aspect relatively spared. The cerebellar vermis and part of the left cerebellar hemisphere were also affected, along with the pons and possible right-sided medulla. Notably, a significant mass effect resulted in 4th ventricle compression, cerebellar tonsillar herniation, supratentorial hydrocephalus, and no evidence of intracranial hemorrhage (see Figs 1 and 2).

After urgently consulting neurosurgery and the medical intensive care unit, the patient was transferred to our facility for

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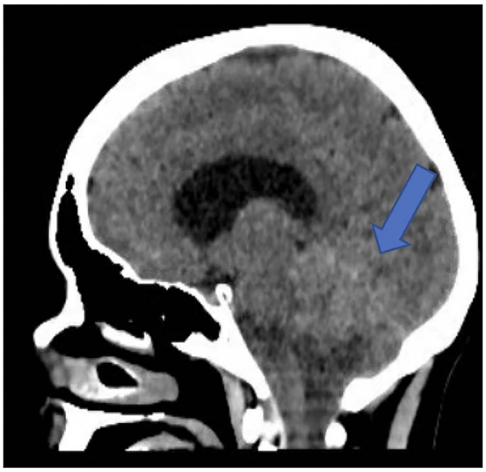

Figure 2. Arrow showing the tonsillar herniation.

life-saving extraventricular drain (EVD) insertion and posterior fossa decompression. In the ED, the patient was electively intubated to protect the airway during the transfer due to a high possibility of deterioration. The patient underwent a right-side EVD insertion, suboccipital craniectomy, and foramen magnum decompression.

The day after the operation, she was extubated and found to be alert, oriented, and following commands. She did not have any focal neurological deficits but complained of vertigo with no headache or other neurological symptoms, and a detailed history was taken from the patient; she reported feeling dizzy and sleepy and experiencing occipital headaches. She had no past medical history. According to the patient, she is a scuba diver and had gone diving two days before her flight. On the same day after her ascend, she experienced a mild occipital headache with mild vertigo. During the dive, she descended to a depth of 6 meters and did not experience any symptoms while descending or ascending. She mentioned that diving to this depth was usual for her.

All blood tests returned within normal levels, including lipid profile and diabetes, and the patient maintained regular blood pressure readings throughout her hospital stay. The patient also underwent magnetic resonance imaging (MRI) of the head and a magnetic resonance angiogram (MRA) of the head and neck after intervention, which showed diffusion restriction as seen in the CT scan and normal appearance of the distal internal carotid arteries, Normal appearance of the middle cerebral arteries, and anterior communication arteries, and Normal appearance of the vertebrobasilar system and posterior communication arteries (see Figs 3–5). Also, as part of the stroke workup, the patient had transthoracic echocardiography, which revealed an incidental finding of patent foramen ovale (PFO). She also had an investigation of ultrasound Doppler in both lower limbs and ultrasound carotid artery, both of which were all unremarkable.

The EVD was removed after eight days, and a repeat CT head showed significant regression of the mass effect and reexpansion of the adjacent sulci and the fourth ventricle. The patient was discharged home after a 16-day hospital stay, fully ambulating and asymptomatic except for mild vertigo, and was prescribed aspirin for stroke prevention. We lost follow-up with the patient after she returned to her home country.

Discussion

For thousands of years, humankind has sought the bottom of the seas, looking for food, medicine, and valuables. In the middle of the 19th century, with the discovery of underwater breathing utilities, diving became more popular, with people resorting to scuba diving for leisure and recreational activities. When diving, a person is exposed to a high level of barometric pressure, and upon immersion, this pressure decreases, rendering the diver susceptible to decompression sickness [3]. Two main types of SCUBA diving are open and closed circuits. Open circuits are mainly used for recreational activities, while the military forces use closed circuits. Both types depend on compressed gas, a mixture of oxygen, nitrogen, or helium [1].

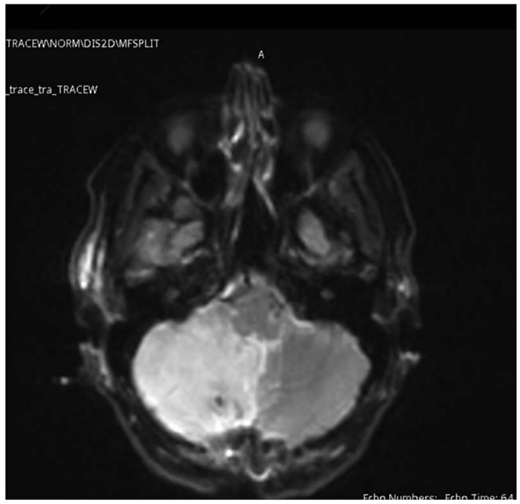

Figure 3. MRI showing right cerebellar stroke.

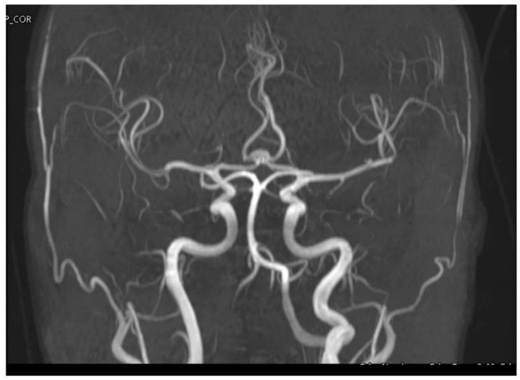

Figure 4. MRA head with normal appearing intracranial arteries.

The impact of SCUBA diving on the human body involves a multifactorial process. Underwater, the cardiovascular system undergoes different physiological changes. During immersion, there's a redistribution of the blood to the center (increased venous return) as a result of elevated hydrostatic pressure, resulting in elevation of pulmonary vascular resistance and enlargement in the atrium and ventricle, and subsequent increase in the left ventricular preload and cardiac output. Enlarging cardiac chambers can increase the risk of developing arrhythmias [4].

In addition, exposure to cool water during diving increases systemic vascular resistance and peripheral vasoconstriction, which can also augment central blood redistribution [5].

As the diver descends into the water, the ambient pressure increases, decreasing the volume of the breathed gas mixture. The gas mixture the diver breathes, including nitrogen, becomes compressed into a smaller area, leading to the nitrogen molecules dissolving into the bloodstream due to increased ambient pressure. This accumulated nitrogen can result in bubble formation.

Figure 5. MRA neck showing normal appearing vessels.

During the ascend, these nitrogen bubbles will be released, and they can cause pressure effects on surrounding tissues, local ischemia, and activation of coagulation pathways [6].

The resultant symptom of this process is called decompression sickness.

There are two types of decompression sickness: type I, where the symptoms are usually milder, like skin changes, headache, and arthritis. In type II, the symptoms are life-threatening, involving the cardiopulmonary and nervous systems [7]. The dissolved nitrogen bubbles can also develop arterial gas embolism, leading to harmful manifestations [8].

Interestingly enough, it has been found that half of the patients with stroke with unknown cause are found to have PFO [9], which might be the case in our patient, as she was diagnosed with incidental finding of PFO, which might have played a significant role in transmitting the nitrogen bubble into the cerebral circulation causing this massive posterior stroke. Another risk factor in our patient is exposure to high altitude, where a reduction of ambient pressure can also result in decompression sickness due to nitrogen being dissolved into the bloodstream [7].

Managing type II DCS is early treatment with hyperbaric oxygen therapy and should not be delayed [10]. The mechanism by which hyperbaric oxygen therapy improves DCS caused by nitrogen gas emboli was described by Boyl's law, stating that the HBOT reduces the volume of the bubbles, which facilitates its removal from the circulation and reverse of the hypoxic state [11], our patient experienced headaches and vertigo after the dive. It worsened when she was on the flight. However, as it is challenging to diagnose posterior stroke because of the variation and the complexity of its presentations [12], our patient was not able to get early hyperbaric treatment, and her condition progressed to a massive stroke, which was treated by supportive measures.

Conclusion

Considering the patient's background and asking for relevant investigations is essential to ensure fast and adequate treatment. Although the effect of scuba diving is still to be studied enough, it is worth knowing that scuba diving might precipitate serious life-threatening complications.

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Conflict of interest

No competing interests declared by the author(s).

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Data availability

The data underlying this article are available in the article and in its online supplementary material.

Ethical approval

The case report meets all ethical guidelines and local legal requirements.

Consent

Informed consent was taken from the patient for publication of this case report and images.

Guarantor

Gufran Algaly.

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