Neurological Aspects of Diving

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The nervous system is exposed to many unfamiliar sensations in underwater diving, both from the external environment as well as from the body's internal environment.

The underwater environment of a diver is very different from normal: the individual is surrounded by a low-gravity water environment, and the sense of touch is often dulled by a wet-suit and gloves. Sounds are strange and give little indication of direction or distance. The vestibular apparatus has to deal with continually changing body positions in three dimensions, and little sensation of gravity. Visual input is often distorted, reduced or even absent in low visibility diving.

In addition to these sensations that can largely be anticipated, unexpected sensations can also arise if the function of the nervous system (e.g. the vestibular apparatus) is upset by changes in the surrounding pressure or temperature.

The internal environment of the body is altered in diving because of the effects of breathing gases under pressure. Oxygen, nitrogen and the other gases in air are dissolved in the blood and tissues in larger amounts at increasing depths. The extra nitrogen may disturb normal brain activity. This effect should be anticipated on any deep dive. An effect of nitrogen that is not however usually anticipated is that of decompression sickness, when too rapid a return of the diver to the surface causes the extra nitrogen in solution to form bubbles within the tissues of the body.

Vertigo

Vertigo is a relatively common symptom in diving. The vestibular apparatus in the inner ears work in tandem and the sensation of vertigo may result if the input to the brain from one vestibular apparatus does not match up with that from the opposite side. Vertigo is a sensation of motion of the environment in relation to the body (or vice-versa) and may be experienced as spinning, falling backwards or forwards, or rocking. It must be differentiated from the vaguer sensation of dizziness, which is less specific. Vertigo is a hazard in a diver as it may not only affect his overall performance and cause him to lose his orientation, but it may also be accompanied by nausea and vomiting.

The commonest cause of vertigo in a diver was described by Lundgren[4] and called *alternobaric vertigo*. It is due to asymmetrical middle ear pressure equilibration during descent or ascent - a frequent problem, particularly among beginners, who have trouble clearing their ears.

Previous disease of the vestibular apparatus which is no longer symptomatic may also cause vertigo during diving. The nervous system can compensate for previous damage to the vestibular apparatus by visual and sensory information. When this compensatory information is not available as when diving, vertigo may result. People with a previous history of vertigo must be screened carefully before they dive.

Apart from these causes, some individuals have one vestibular apparatus inherently more sensitive than the other to changes of temperature and position and these people are prone to develop vertigo when they dive. Vertigo may also be a symptom of nitrogen narcosis or decompression sickness.

Nitrogen Narcosis

Under pressure, nitrogen takes on the properties of an anaesthetic gas. The narcosis it causes is due to its increased fat solubility at high pressures which causes impairment of transmission of impulses at brain synapses. The increased pressure of nitrogen at a depth of 300 feet is sufficient to render a man unconscious. At lower pressures nitrogen causes "narcosis", which is a state that is similar in many ways to alcohol intoxication.

Symptoms start at about 100 feet with a feeling of light-headedness and euphoria. This is combined with a slowing of higher mental functions and a disturbance of short-term memory. The symptoms get increasingly severe as depth increases. Recovery is rapid on returning to the surface but there may be some loss of memory for events during the period of narcosis. Alcohol, hangover or stress may make narcosis worse[1].

Decompression Sickness

The nervous system is involved in up to 35% of severe cases of decompression sickness, and these are the most serious, as a permanent deficit such as paraplegia may result[5 2]. Symptoms may develop immediately on decompression or may be delayed for up to 15 hours after a dive. Obvious symptoms of nervous system involvement may be preceeded and overshadowed by symptoms such as limb or muscle pains; a combination of shortness of breath, chest pain and cough called *the chokes*; or just a general sensation of fatigue and feeling unwell. It is important that neurological involvement, which often develops slowly and insidiously, is not ruled out until a careful history and examination are performed, as it is often overlooked. Almost any neurological symptom can be produced ranging from headache and blurring of vision to convulsions and coma, so it is important that any unusual complaints following a deep dive are taken seriously.

The most common site of damage is the spinal cord which is involved in 80% of cases with neurological symptoms[3]. This usually presents with sensory symptoms such as pins and needles in the feet coupled with a slight weakness and unsteadiness of the legs. This may slowly or rapidly lead to complete paralysis of the legs and loss of control of bladder and bowels.

The treatment of decompression sickness is recompression in a decompression chamber as soon as possible. The longer the delay in starting treatment, the more likely is the patient to suffer permanent disability.

High Pressure Nervous Syndrome

Very deep diving (with oxygen-helium to avoid nitrogen narcosis) to depths greater than 500 feet can produce a syndrome consisting of tremors of the arms and legs, myoclonic jerks, fatigue and even convulsions. The cause of the High Pressure Nervous Syndrome is unkown but it is thought to be a direct effect of high pressure on the nerve cell membranes. Much research is being done on this syndrome as it causes problems for very deep diving and sets limits to depths which divers can attain and at which they can work efficiently.

References

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