

Chapter 31

DISORIENTATION

Accurate orientation whilst underwater is important for the diver so that he can find his way back to the surface. On land the diver uses a combination of vision, the feeling of gravity on his body, and the balance organs (vestibular system) to tell him which way is up.

When underwater, the diver becomes virtually weightless, depriving him of the sensation of gravity and making him reliant on vision and his balance organs for spatial orientation. With poor visibility, even the visual cues are lost, leaving the diver almost totally reliant on his balance organs for this orientation. A sensation of disorientation requires investigation by a diving physician.

The experienced diver can acquire some clues about his body position from:

- the way heavy objects such as the weight belt or other metal objects hang,
- the direction his bubbles are going,
- the direction of a life-line or hookah hose.

Inexperienced or panicking divers are often unable to use this subtle information. If the diver becomes disoriented he is likely to experience anxiety. Panic can easily ensue.

VERTIGO — OR "DIZZINESS"

This is a false sensation of spinning or moving. The diver may either have a sensation of himself spinning or the environment spinning about him. It happens because the balance organ (**vestibular system**) can be unreliable underwater – it was designed to work on land. Under certain circumstances it can supply the brain with misleading information which is falsely interpreted as movement.

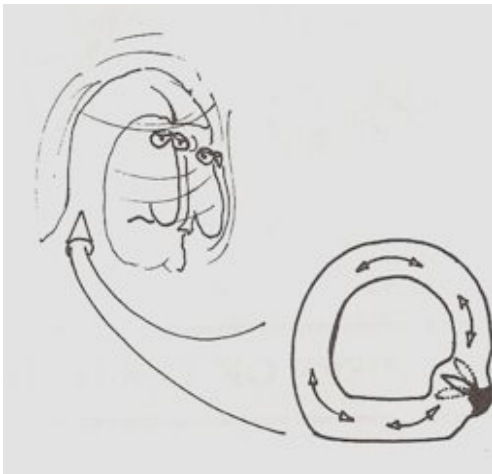
The sensation of vertigo is bad enough, but it is often accompanied by **nausea** and **vomiting** which can threaten a diver's life. These symptoms may vary from mild to very severe. Vomiting into, and then breathing from, a demand valve is not easy underwater.

Function of the Vestibular System

The balance or vestibular system comprises two marble-sized structures located in the skull above and behind the middle ear space on either side of the head. Each vestibular apparatus has two parts. Abnormalities of either cause vertigo and disorientation. They are:

□ A system of three interconnecting tubes (semi-circular canals).

These are aligned at right angles to each other and filled with fluid. They detect movement in all three planes. If the body rotates, the fluid in these three canals tends to lag behind, due to its inertia. The differential movement of the body and the fluid is detected by nerve endings – hair like projections into the fluid (hair cells) at the base of each canal.



The semi-circular canals are located close to the ear canal. Cold water entering the ear canal can cool them slightly, causing convection currents in the fluid. The movement of the fluid is detected by the hair cells and, if this does not synchronise with stimuli from the other side, causes vertigo. This is termed **caloric** induced vertigo and is usually associated with the diver being in a near horizontal position.

Fig. 31.1

□ The Otolith organ.

These other fluid-filled structures have a viscous base which contains minute calcium granules. Hair like projections of nerve cells penetrate this gel and detect any movement of the granules. Because of their weight, the granules tend to move in response to **gravity** and **acceleration**. The hair cells detect this and continuously inform the brain about which way is up and the direction of any acceleration.

Pressure changes can cause **barotrauma** induced vertigo, and it is possible that this could be due to stimulation of the otoliths or the semicircular canals and is usually associated with the diver being in a more vertical position.



Fig. 31.2

CAUSES OF VERTIGO

Problems arising from the vestibular system fall into two principle categories:

- unequal vestibular stimulation and
- unequal vestibular response.

Unequal Vestibular Stimulation

If both vestibular systems are equally sensitive but are stimulated unequally, then vertigo may result due to the unequal responses received by the brain.

Any condition causing more cold water to enter one external ear more than the other causes unequal **caloric** stimulation. Wax blocking one ear, an air bubble, otitis externa, exostoses, ear plugs or a ruptured ear drum will all have this effect.

With middle or inner **ear barotrauma** (see Chapter 9) affecting one side, or **decompression sickness** (see Chapter 15) on one side, unequal vestibular stimulation may result in vertigo.

Failure of the ears to equalise pressures to the same degree can stimulate the vestibular system unequally. This is not uncommon on ascent, as the pressure of the expanding gas in the middle ear spaces can become greater on one side than the other due to differences in patency of the Eustachian tubes releasing it. This is termed **Alternobaric Vertigo** or **middle ear barotrauma of ascent** (see Chapter 9). It is very common and is often noticed as the diver ascends a metre or so, from depth. He may even be aware of the sensation of one Eustachian tube opening before the other, or of the expansion of air in the other middle ear.

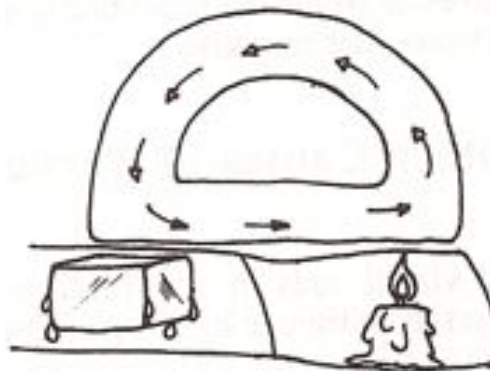


Fig. 31.3
Caloric stimulation producing "convection" current flows in inner ear fluids.

Case Report 31.1. A diver using hookah apparatus on a training dive at night lost contact with the bottom. He was unable to see his bubbles and had no idea which way was up, but by feeling the direction of his air hose, he was able to establish where the surface was.

Diagnosis: disorientation due to the reduced sensory input (decreased vision) of night diving.

Case Report 31.2. An inexperienced diver had difficulty equalising his middle ear during descent. He continued to descend in spite of this. The pain was abruptly relieved and he became aware of a hissing sound and cold sensation in his ear as his ear drum perforated. Seconds later he developed a severe sensation of spinning which was accompanied by nausea. He clung onto his shot line and was relieved when the vertigo gradually passed off after several minutes.

Diagnosis: Vertigo due to one sided vestibular stimulation (caloric) from cold water entering the middle ear when the ear drum ruptures. As the water warmed to body temperature, the cooling effect to the vestibular system subsided.

Unequal Vestibular Response

The two vestibular systems are normally equally sensitive to any stimulus such as movement. Some people may have unequal sensitivity. This can be due to a slight imbalance (either overactive or underactive function) which has been present from birth or to damage to one side from causes such as ear barotrauma or some medical conditions. In this situation, the same stimuli cause a greater response from one side than the other, and is experienced by the person as vertigo.

People with this problem unconsciously adapt by avoiding sudden movements of the head or body. They learn by experience to avoid gymnastics and roller coaster rides, but are usually not aware of the dangers posed to them by the extreme stimuli which are commonplace in diving.

Water entering the ear canals is a potent cause of vertigo in these people. As mentioned above, this water can cool the fluid in the semi-circular canals setting up convection currents (**caloric stimulation**). If the vestibular systems on each side are not equally sensitive, a stronger response will be produced from one side. The brain will interpret this information as indicating movement, and the diver will experience vertigo and feel disorientated.

During ascent or descent, equal **pressure changes** in the middle ear can also produce vertigo and disorientation in those with unequal vestibular response.

Other Causes of Vertigo

If the diver is deprived of normal visual cues in conditions of **poor visibility** or at night, it is possible for the resulting disorientation to culminate in vertigo, especially in inexperienced divers.

Nitrogen narcosis may aggravate vertigo. Vertigo has also been recorded as a symptom of other conditions not commonly encountered by recreational divers. These include **oxygen toxicity**, **carbon dioxide toxicity**, **carbon monoxide toxicity**, and **high pressure neurological syndrome**.

PREVENTION

A thorough diving medical examination before a prospective diver undertakes training can exclude some of the factors predisposing to vertigo, and is advised for all divers.

A diver experiencing vertigo under water should avoid unnecessary movement and hold onto a fixed object if one is available. Fortunately, in most cases, the vertigo is short lived. If the vertigo fails to abate and there are no obstacles above him, ditching of weights, possibly with cautious inflation of a buoyancy compensator, should return the diver to the safety of the surface.

Any diver who experiences vertigo under water and survives should abandon the dive, **consult a diving physician** to investigate, identify and correct the cause before diving again.

Occasionally the diver may be very astute and be aware of the cause of the vertigo, and may then correct the problem e.g. with middle ear barotrauma of ascent (see Chapter 9).

CONCLUSIONS

While **disorientation** under water can be unpleasant and dangerous, **vertigo** can be life threatening because of the risk of vomiting or panic.

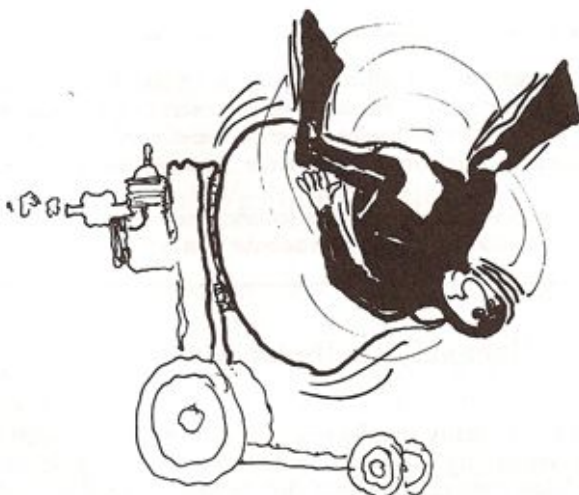


Fig. 31.4