Hydrocephalus, shunts, and scuba diving – can this be safe?

Can someone with a shunt go scuba diving?

The answer to this question is not an easy one and a bit complex. In general, a shunt is a system that shifts fluids. In this specific case a shunt is an artificial pathway made of fine tubes, a catheter, and a valve. The fluid to be shifted is from the brain to the body's periphery because the person has been diagnosed with a hydrocephalus (from Greek "hydro" for "water" and "cephalus" for "head").

Our brain and spinal cord swim in a so-called cerebrospinal fluid (CSF) that buffers it against concussions and also protects it otherwise. Scientifically it's called Liquor cerebrospinalis. The CSF fills cavities, so-called ventricles in the brain. Usually the CSF is produced and then absorbed by the brain and its adjacent layers in a balanced way. A hydrocephalus is caused by a deficiency regarding the absorption of the brain's fluid which can evolve from a bleeding in the brain caused by a previous stroke or ruptured aneurysm, or can just be a birth defect. It is a very serious, life-threatening neurological condition and jeopardizes all vital functions since it puts the brain under increasing pressure. The pressure cannot go anywhere because the skull is a bony and solid structure which cannot expand.

The symptoms of a hydrocephalus may be low blood pressure, bradycardia, slurred speech, inability to walk, speak, think, eat, drink or act in any way, extremely slow movements, comatose tiredness and, finally unconsciousness. A person with these symptoms needs immediate help and medical attention. In an emergency situation like this, a neurosurgeon will drill a hole in the skull and release the fluid and the pressure. If the hydrocephalus is a permanent condition, the insertion of a shunt system is indicated as a permanent solution to continuously release the superfluous fluid from the brain. People can live a normal – terrestrial – life with a shunt.

The shunt's catheter is positioned centrally in the brain's ventricular system and connects to the tube via an adjustable unidirectional overpressure valve. The tube runs subcutaneously, i.e. under the skin, along one side of the body and leads either into the abdominal cavity or to the atrium of the heart. Fluid will be shifted from the brain to the periphery of the body when the pressure in the head overcomes the pressure setting of the valve.

Those shunts are called either VP shunt or VA shunt. VP stands for ventricular-peritoneal and VA for ventricular-atrial. "Peritoneal" means the abdominal cavity (peritoneal cavity), "home" to our inner organs and intestines, while "atrial" refers to the atrium of the heart. Both peritoneal cavity and atrium have the capacity of taking up the additional fluid which can be absorbed and finally be excreted via the kidneys. Which shunt system is inserted lies mainly upon the discretion of the operating neurosurgeon.

Shunts shift fluids and under normal circumstances there would be no air involved. Therefore, pressure differentials are not necessarily expected from the changes in pressures of diving. Ventriculo-peritoneal (VP) shunts are considered less likely to cause problems when diving whereas ventriculo-atrial shunts (VA) bear an increased risk of bubble formation at the point of shunt insertion, shunt malfunction due to high pressure or extreme pressure changes, and an increased risk of epilepsy following the insertion. In case of such epileptic seizures a seizure-free and anticonvulsant-free period of at least 5 years would be required before considering diving or going back to diving again.

Studies have shown that a person with a VP shunt is assumed to be able to dive safely up to four

atmospheres of pressure. This means that it is most likely safe to dive down to 100 feet (33m), as was demonstrated in hyperbaric chambers where normal functioning of the shunts up to this pressure was shown. Specialists believe a VP shunt will drain normally because the ventricles in the brain as well as the abdomen will be equally affected by the increased ambient pressure of the deeper water. VA shunts, however, are affected by the blood stream in which nitrogen bubbles may form while surfacing from a dive. These bubbles have the potential to interfere with the well-functioning of the shunt. VA shunts are therefore not allowed by most diving certification agencies.

Clearly, diving should be suspended if there are any problems with breathing, headaches or neurological disorders (like spasticity). People with shunts should be warned about the risk that there is poor functional reserve in case of either any problem with the shunt or any problem with DCI. Regarding DCI, as long as the hydrocephalus is managed well and the ventricles are not enlarged, it is not assumed that there is an increased risk of DCI in VP shunt carriers.

Another real threat can be infections. Surgery sutures after shunt insertion should be healed completely before any water – fresh- or sea water – comes in contact with them. The catheter reaches into the brain's ventricular system but its other end is just below the skin of the skull. If there is a wound on the scalp close to the top ending of the catheter and the area gets infected, it could quickly reach the brain – and a brain infection is a life-threatening scenario.

Generally, a person with a shunt should think twice whether traveling abroad and diving in remote locations are both activities worth considering. In order to make an informed decision about it, it is advisable to consult a neurosurgeon specialized in shunt systems and a dive physician knowledgeable in the same field. Both neurosurgeon and diving physician need to know the entire medical history, the pre-existing condition that led to the insertion of the shunt, and the person's current health status before they can give a complete answer.

In most cases, a person with a hydrocephalus has experienced serious, life-threatening temporary brain deficiency. Only quick diagnosing and immediate insertion of a shunt system have probably saved the normal brain function. A shunt system is an artificial and technically complicated system. Material damages or defects can occur – as in any artificial system. Such dysfunctions or malfunctions require immediate intervention. Only a clinic with a neurosurgical department can help in this situation. Determining a shunt dysfunction or malfunction usually requires brain imaging with a CT (computer tomography). After locating the defect and determining its severity, it will require immediate brain surgery and probably a replacement or partly revision of the shunt system. In some cases, only the valve may need adjustment. Not every clinic has this special technical equipment. Some valves can be adjusted by magnets from the outside and surgery will not be necessary but you need to find a hospital with this specific magnetic system. Since there are several valve and shunt systems on the market, you are lucky to find one that has exactly yours, and really unlucky if you don't. In many dive spots such state-of-the-art medicine and higher standard health care might not be easily available.

Take home message:

Divers with a shunt should watch out for neurological disabilities, numbness of extremities and "autonomic" instabilities (e.g., postural hypotension, blood pressure changes and disability to react to cold water immersion). Neurological deficits should be documented for any diving physician in case of an accident. A copy (or the original) of the valve pass should be carried. The shunt should be fully functional and have no dysfunction.

You should get information what kind of restrictions you have to follow while diving with a shunt. Neurosurgeons and dive physicians should well explain the involved risks. It is advised to arrange dives with specially trained dive instructors and to inform dive buddies about the implanted shunt system.

Be a responsible diver! Good luck and good health to you!