Common Ear Injuries While Diving

By Bruce Delphia, DAN Training Staff Specialist

NOTE: No article can give you the same degree of information as an experienced medical practitioner. DAN suggests all persons with any ear discomfort should be examined by a trained medical practitioner as soon as possible after the complaint develops.

What's the most frequent diving injury? Decompression illness, right?

No, it's ear injuries. The most common injury divers experience is some form of barotrauma to the ear. Barotrauma means injury from pressure (baro = pressure + trauma = injury). This type of injury occurs for a variety of reasons, but generally it develops when the pressure in the middle ear is not equal to the pressure of the outside environment as the diver descends in the water column. (But see **Barotrauma on Ascent**) Because of the rapid relative gas volume change as the diver descends at the beginning of the dive, the first 14 feet / 4.2 meters of the descent is where the ear is at most risk of injury.

ANATOMY OF THE EAR
No discussion of the examination of any part of the human body could be complete without a working knowledge of the anatomy of that part. The ear is made up of three compartments: the external ear, the middle ear and the inner ear.

The External Ear Auricle and the External Ear Canal
The auricle (pinna), is the first and most obvious view of the ear. It's what we generally refer to as the ear, although it is just the outside section of it. Funnel-shaped and mostly cartilage covered by a thin layer of skin, it channels sound (and water) into the ear.

Directly behind the tragus, the cartilaginous prominence in front of the external opening of the ear, the ear canal curves inwards approximately 24 millimeters in the average adult. The outer portion of the ear canal contains the glands that produce earwax (cerumen). The inner portion of the ear is covered by thin, hairless skin. Pressure on this area can cause pain.

The Middle Ear
At the inner end of the ear canal, separating the external ear from the middle ear, is the tympanic membrane, or eardrum. The middle ear is an air-filled space that contains the ossicles - three tiny bones that conduct sound. (many of us learned them as the hammer, anvil and stirrup: in medical terminology they are the mallus, incus, and stapes. See **How the Ear "Hears"**)

The Eustachian tubes, one in each ear, connect the middle ear and the back of the throat (nasopharynx). They keep the middle ear "equalized" by keeping the air pressure on both sides of the eardrum the same. Because they are surrounded by cartilaginous tissue they don't allow for expansion. Therefore a diver must equalize his or her ears by gently "opening" the tubes—that is, by introducing air through them and into the middle ear.

The Inner Ear
Separating the middle ear from the inner ear are two of the thinnest membranes in the human body, the round and oval windows. These membranes embody one of the reasons divers are taught to gently blow to equalize their middle ears — damage to the round or oval windows may cause a leakage of fluid from the inner to the middle ear. This can cause a ringing or roaring in the ears, and even hearing loss. Window rupture can also cause severe vertigo and vomiting, a dangerous — even deadly — combination when underwater.

COMMON INJURIES TO THE EAR ASSOCIATED WITH SCUBA DIVING
Otitis externa (swimmers ear): This is an inflammation of the external ear caused by infection. Some people are prone to developing this kind of infection. If the ear remains moist from immersion in the water, this moisture, coupled with the warmth of the body, creates an inviting growth area for many microorganisms, especially opportunistic bacteria. For more details on this, see **Can You Prevent Otitis Externa, or Swimmers Ear?**.

Signs & Symptoms: The ear canal can become inflamed and may partially close. The external ear canal is red and swollen and may itch. Touching the outer ear may cause intense pain.

Treatment: Prevention is key, especially in those persons who have previously shown they are susceptible. Domeboro Otic , solution, available at drugstore, may function as a prophylactic and treatment for otitis externa when it is used as directed.

Barotitis Media (middle ear barotrauma): This is by far the most frequently reported injury among divers. People with barotitis media generally develop symptoms immediately following the dive, but delays of up to one day or longer have been reported. When the diver descends, the pressure can cause injury to the middle ear. This overpressure of the middle ear can cause serious fluid and blood to leak into the middle ear, partially or completely filling it.

Signs & Symptoms: A feeling of fullness in the ear may develop, like the feeling of fluid inside the ear. Muffled hearing or hearing loss are other indications of middle ear barotrauma. On examination with an otoscope (a special device medical personnel use when examining the ear) fluid may appear behind the tympanic membrane, causing it to bulge and appear red. In other cases, the eardrum may be retracted or sunk in. Either condition warrants immediate medical attention.

Treatment: First, diving must stop. Also, changes in altitude—as with flying—must be considered a concern as well. See a medical practitioner. The combination of drugs and time will usually allow this injury to heal in a few days, but cases have lasted up to several months. If you have been on decongestant therapy for seven days and have experienced little or no relief, it's time to see your otolaryngologist, an ear, nose and throat (ENT) specialist.

Otitis Media (middle ear infection): This is not a diving malady, but may look the same as middle ear barotrauma to a non-dive-trained medical practitioner. Because the treatments can vary, it is important to realize that an ear problem immediately following a dive outing usually signals a pressure-related injury rather than an infection.

Inner Ear Barotrauma: This injury generally occurs when divers attempt to forcefully equalize their ears. This "hard" blowing over-pressurizes the middle ear and can result in implosive or explosive damage to the round and oval windows.

Signs & Symptoms: Vertigo, vomiting, hearing loss, loud tinnitus (a ringing or roaring sound in the ear).

Treatment: Place the injured diver in a sitting head-up position. Get the injured diver to medical help right away, preferably to someone knowledgeable in diving medicine since inner ear barotrauma may be difficult to distinguish from inner-ear decompression sickness.

Tympanic Membrane (TM) Rupture: Barotraumatic injuries to the ear may result in perforation or rupture of the tympanic membrane. This may occur in as little as 7 feet / 2.1 meters of water.

Signs & Symptoms: Generally there is pain and bleeding from the ear. This may not always be the case, as a number of dive-related traumatic TM ruptures have reported no pain at all. Hearing loss and tinnitus may also be present, but not always. A discharge from the ear of commingled fluid and blood may be a sign of TM rupture.

Treatment: Go to the nearest medical practitioner immediately for an examination. Do not re-enter the water if you suspect TM rupture: water entering the middle ear cavity may cause severe and violent vertigo. Do not put any drops of any kind in your ear. Do not attempt to equalize your middle ears.

External Ear Canal Superficial Vessel Rupture: This occurs more often in divers who wear hoods. Occasionally, the overpressure may rupture a blood vessel inside the external ear canal, causing some minor bleeding.

Signs & Symptoms: A minute trace of blood trickling from the ear canal. Later, the injured diver may find drops of blood on his/her pillow or bedclothes.

Treatment: In order to distinguish between this injury and other, more severe injuries, it is necessary to stop diving and seek evaluation by a medical practitioner.

On a general note, a physician should examine any ear problem that drains purulent material (pus) or has a foul or disagreeable odor.

SUMMARY
Ear injuries are the most commonly encountered injuries to divers. Permanent hearing loss may result from barotrauma to the ears. The likelihood of injuries is reduced by preventive measures such as:

- properly equalizing
- never diving with a cold or other congestion, and
- abstaining from diving if you cannot clear your ears.

Several types of ear injuries can occur. All of these injuries should be examined by a qualified medical practitioner. If in doubt regarding the practitioner's knowledge of diving medicine, bring this article with you or encourage them to call +1-919-684-2948 and ask for the Medical Department here at DAN for a consult.

Otoscopic examination of the ear by a qualified medical practitioner knowledgeable in diving and emergency medicine may be useful in determining what type injury has occurred. In remote areas of the world or on board liveaboard dive vessels you may have to wait a while until you can get medical help. DAN's advice is to encourage you to get to a medical facility as soon as possible.

Good diving, and keep your ears dry!

How the Ear "Hears":

Sound travels as vibrations through the air of the external ear canal. These vibrations are transmitted through the tympanic membrane to the ossicles. The movement of the ossicles transmits the vibrations through another thin membrane into the fluid in the cochlea in the inner ear, where they are converted to fluidic pressure changes. Special structures and cells in the cochlea convert the fluidic pressure changes into nerve impulses. The nerve impulses are then transmitted to the brain through a portion of the eighth cranial nerve, where they become sounds.

Barotrauma on Ascent

Barotrauma of ascent can also occur. It happens when gases in the middle ear expand with ascent and become blocked, causing tissue damage similar to barotrauma of descent. This malady is less common, because, in all probability, any blockage will usually be felt first upon descent by blocking the Eustachian tubes.

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