



HEALTH & DIVING REFERENCE SERIES



FOREWARD

DAN's Health & Diving Resource Series is a comprehensive collection of online and printed resources developed from years of DAN-supported research and insights gained from assisting thousands of members through dive and medical emergencies. These materials provide valuable information on topics critical to diver health and safety, as well as common issues encountered by new and experienced divers. As your dive safety association, it is our duty to provide the diving community with these vital education and reference tools. The series offers greater insight into topics such as ears and equalization, cardiovascular health, decompression sickness, hazardous marine injuries, and much more. Through information and education, we hope to enhance diver safety and incident prevention.



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KEY INFORMATION

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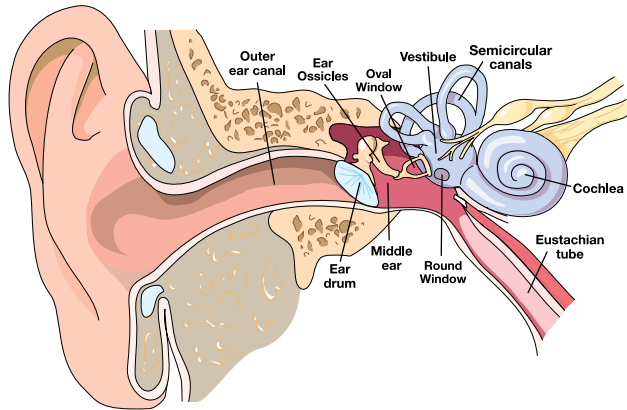
The ear is the organ of hearing and balance.

The ear is a complex organ that enables orientation in space, everyday physical activities and social communication. While the anatomy of the ear may be intimidating to some extent, we tried to provide a simplified but explanatory picture to enhance your comprehension of processes important for diving. Pressure equalization in the middle ear is the most important skill for divers. If not mastered properly, divers can get injured and sometimes permanently disabled. In divers with healthy ears, ear barotrauma is preventable. Divers should invest time and effort to master equalization techniques.

To learn more about ears and diving, visit [Youtube.com/DiversAlertNetworkTV](https://www.youtube.com/DiversAlertNetworkTV) and watch the video seminars.

ANATOMY OF THE EAR

The ear is the organ of hearing and balance. It consists of a cavity in the skull structure lined with soft tissue, which encloses three distinctive spaces filled with air or liquid (external, middle and inner ear); these distinctive spaces host both sound transmission mechanisms and sensory apparatuses.



STRUCTURE

The external ear includes the pinna (auricle) and the ear canal up to the eardrum (tympanic membrane), which separates it from the middle ear. The lining of the external ear is skin rich with glands that produce earwax.

The middle ear is a cavity in a temporal bone lined with a thin layer of tissue similar to that found in the nose and throat. It is separated from the ear canal by the eardrum and connected to the throat via the Eustachian tube. It includes three tiny bones (auditory ossicles) forming the chain attached to the eardrum on one side and to the oval window membrane on the inner ear side. The middle ear space is filled with air at ambient pressure, which needs to be equalized when ambient pressure changes (as occurs in diving or flying). This is

accomplished by moving air in or out through the Eustachian tubes, which connect the throat to the middle ear, using equalization techniques like the Valsalva maneuver.

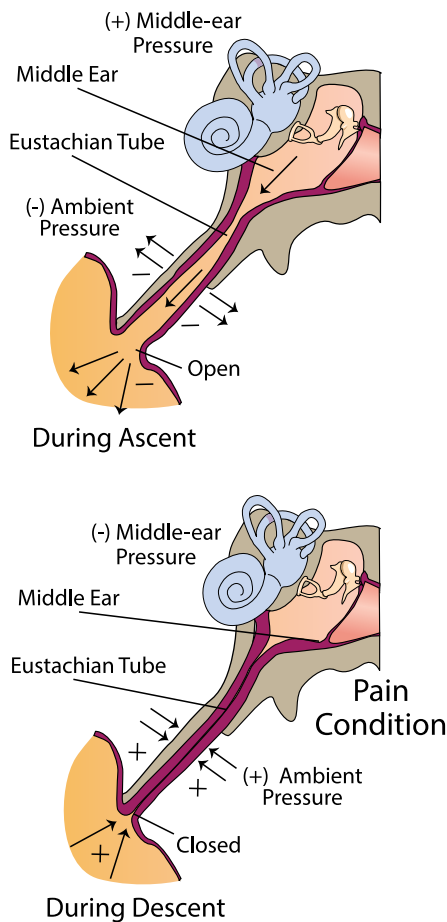
The inner ear, or labyrinth, includes the cochlea (hearing organ) and the vestibule and semicircular canals (balance organs). The cochlea and the vestibule are the origin of the auditory and vestibular nerves.

FUNCTION

Pressure waves transmitted by air or water are funneled by the pinna and the ear canal to the tympanic membrane. The pressure waves cause the tympanic membrane to vibrate, which causes the auditory ossicles to move simultaneously in response. The stapes (the last bone in the chain) strikes the oval window of the cochlea. Since this is a closed system, when the oval window is pushed inward, the round window pushes outward. The fluid within the cochlea transmits the pressure waves to the auditory nerve, which in turn, sends signals to the brain that are interpreted as sound.

Parts of the vestibule are projections known as the semicircular canals. The fluid within this system moves correspondingly with head movement. Inside the semicircular canals are hair-like structures called cilia. The cilia detect movement of the fluid through the canals and through the vestibular nerves send the signals to the brain where the movement is interpreted and used to help determine the position of the head in three-dimensional space.

MIDDLE EAR EQUALIZATION



Middle ear equalization is a basic, required diver skill that enables the equalization of the pressure in the sinuses and middle ear spaces with ambient pressure.

PROCEDURE IN PRACTICE

As divers descend in the column of water, environmental pressure increases in a linear fashion at a rate of one-half pound per square inch (PSI) for each foot (0.1 kg/cm² for each meter) and transmits across the body tissues and fluids. Boyle's law describes how the volume of the gas decreases when pressure increases, if the amount (mass) of gas and the temperature remain the same. The middle ear is a rigid cavity with exception of the eardrum. So when pressure increases, the only way for the volume to decrease is the bowing of the eardrum toward the middle ear cavity (unless gas is added to the space). After the eardrum stretches to its limits, further reduction of middle ear cavity volume is not possible, and if descent continues the pressure in the middle ear cavity remains lower than its surroundings. Modest pressure difference will cause leakage of fluid and bleeding from the eardrum and mucosa lining the middle ear cavity (ear barotrauma O'Neil grade 1). When the pressure difference reaches 5 PSI (0.35 bar), the eardrum may rupture in some divers; at a pressure difference greater than 10 PSI (0.75 bar), rupture will occur in most divers (ear barotrauma O'Neil grade 2). In addition, sudden and large pressure changes may cause inner ear injury.

So now you understand why during descent you must let more gas into your middle ear to keep the volume of the gas constant and equalize the pressure. A normal

middle ear has only one physical communication with the source of additional gas, and that is the Eustachian tube that connects to the nasal cavity (rhinopharynx). Under normal circumstances, the Eustachian tubes are closed, but every time we swallow or yawn, the muscles in our throat allow for a small transient opening that is enough to ventilate our middle ear and compensate pressure.

Nothing challenges our ears and Eustachian tubes more than scuba and breath-hold diving. In order to become a safe scuba diver and avoid middle ear injuries, it is essential that you understand the effects of Boyle's law and learn how to actively let air into your middle ears via the Eustachian tubes. In the following sections on this booklet, you will find different equalization techniques for you to try.

On ascent, the surrounding pressure decreases and the pressure in the middle remains higher if the gas has no way to leave the middle ear cavity. When the pressure in the middle ear exceeds surrounding pressure by 15-80 centimeters of water (cm H₂O) which corresponds to an ascent in water of 0.5-2.5 feet, the Eustachian tubes open and surplus gas escapes. If your ears do not equalize at the same rate and the pressure difference reaches about 66 cmH₂O (2 feet), vertigo due to unequal pressure stimulus (alternobaric vertigo) may occur.

Upper respiratory tract infections, hay fever, allergies, snorting drugs, cigarette smoking or a deviated nasal septum may compromise equalization. When properly employed, the following techniques are effective in middle ear and sinus squeeze in healthy subjects.

EQUALIZATION TECHNIQUES

Passive: Requires no effort. Occurs during ascent.

Voluntary Tubal Opening: try yawning or jaw wiggling. Up to 30% of divers can successfully master this technique

Valsalva Maneuver: Pinch your nostrils and gently blow through your nose.

Toynbee Maneuver: Pinch your nostrils and swallow (good technique, if equalization is needed during ascent).

Frenzel Maneuver: Pinch your nostrils while contracting your throat muscles and make the sound of the letter “k”.

Lowry Technique: Pinch your nostrils and gently try to blow air out of your nose while swallowing (think Valsalva Maneuver meets the Toynbee Maneuver).

Edmonds Technique: Push your jaw forward and employ the Valsalva Maneuver or the Frenzel Maneuver.

TIPS FOR EQUALIZATION

- 1 Prior to descent, while you are neutrally buoyant with no air in your buoyancy control device (BCD), gently inflate your ears with one of the listed techniques. This gives you a little extra air in the middle ear and sinuses as you descend.
- 2 Descend feet first, if possible. This allows air to travel upward into the Eustachian tube and middle ear, a more natural direction. Use a descent line or the anchor line to control the speed of descent.
- 3 Inflate your ears gently every few feet for the first 10 to 15 feet.
- 4 Pain is not acceptable. If there is pain, you have descended without adequately equalizing. Ascend a few feet until the pain stops.
- 5 If you do not feel your ears opening, stop and try again; you may need to ascend a few feet to diminish the pressure around you. Do not bounce up and down.
- 6 It may be helpful to tilt the blocked ear toward the surface.
- 7 If you are unable to equalize, abort the dive. The consequences of descending without equalizing could ruin an entire dive trip or cause permanent damage and hearing loss.
- 8 Decongestants and nasal sprays may be used prior to diving to reduce swelling in the nasal and ear passages. If your doctor agrees with your decision to use decongestants, take them one to two hours before descent. They should last from eight to 12 hours so you don't need to take a second dose before a repetitive dive. Nasal sprays should be used approximately 30 minutes before descent and usually last 12 hours. Take caution when using over-the-counter nasal sprays; repeated use can cause a rebound reaction resulting in increased congestion and possible reverse block on ascent. Decongestants may have side effects. Do not use them before dive if you do not have previous experience.
- 9 If at any time during the dive you feel pain, experience vertigo or note sudden hearing loss, abort the dive. If these symptoms persist, do not dive again and consult your physician.



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INJURIES

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At least 40% of all DAN medical calls & emails are about ear concerns.

Ear injuries are the leading cause of morbidity among scuba divers. The most common injury is middle ear barotrauma (MEBT). Most cases of MEBT are mild, heal spontaneously and are never reported. In more serious cases, divers seek medical attention and some call DAN. Various surveys indicate that more than 50% of all divers experience MEBT at least once. In contrast, only 4.4% of divers experience DCS in their lifetime.

Divers are affected by various other ear injuries, many of which are preventable, that will be detailed in the chapter that follows.

MIDDLE EAR BAROTRAUMA (MEBT)

Middle ear barotrauma is the accumulation of fluid and blood in the middle ear or eardrum rupture as a consequence of failed equalization of pressure in the air space of the middle ear during diving or flying.

MECHANISMS

The air pressure in the tympanic cavity—air-filled space in the middle ear—must be equalized with the pressure of the surrounding environment. The Eustachian tube connects the throat with the tympanic cavity and provides passage for gas when pressure equalization is needed. This equalization normally occurs with little or no effort. Various maneuvers, such as swallowing or yawning, can facilitate the process.

An obstruction in the Eustachian tube can lead to an inability to achieve equalization particularly during a descent when the pressure changes fast. If the pressure in the tympanic cavity is lower than the pressure of the surrounding tissue, this imbalance results in a relative vacuum in the middle ear space. It causes tissue to swell, eardrum to bulge inward, leakage of fluid and bleeding of ruptured vessels. At a certain point, active attempt to equalize will be futile and forceful Valsalva maneuver may actually injure the inner ear. Eventually, the eardrum may rupture; this is likely to bring relief from the pain associated with MEBT but it is an outcome to be avoided, if at all possible.

Factors that can contribute to the development of MEBT include the common cold, allergies or inflammation—conditions that can cause swelling and may block the Eustachian tubes. Poor equalization techniques or too rapid descent may also contribute to development of MEBT.

MANIFESTATIONS

Divers who cannot equalize middle ear pressure during descent will first feel discomfort in their ears (clogged ears, stuffed ears) that may progress to severe pain. Further descent only intensifies the ear pain, which is soon followed by serous fluid buildup and bleeding in the middle ear. With further descent, the eardrum may rupture, providing pain relief; this rupture may cause vertigo, hearing loss and exposure to infection.

MANAGEMENT

While Diving: When feeling ear discomfort during descent, you should stop descending and attempt equalization. If needed, ascend a few feet to enable equalization. If equalization cannot be achieved, you should safely end the dive.

First Aid: When feeling fullness in one's ears after diving, abstain from further diving. Use a nasal decongestant spray or drops. This will reduce the swelling of nasal mucosa and Eustachian tube mucosa, which may help to open the Eustachian tube and drain the fluid from the middle ear. Do not put any drops in your ear.

Treatment: Seek a physician evaluation if fluid or blood discharge from the ear canal is present, or if ear pain and fullness lasts more than a few hours. If vertigo and dizziness are present, which may be a symptom of inner ear barotrauma, you should seek an urgent evaluation. Severe vertigo and nausea after diving require emergency medical care.

FITNESS TO DIVE

Return to diving may be considered if a physician determines that the injury is healed and the Eustachian tube is functional.

PREVENTION

- I Do not dive with congestion or cold.
- I Descend slowly. If unable to equalize after a few attempts, safely end the dive to avoid significant injury that may prevent you from diving the rest of the week.

TYMPANIC MEMBRANE RUPTURE (PERFORATED EARDRUM)

Tympanic membrane perforation is a tear of the eardrum, which can occur while scuba diving due to failed middle ear pressure equalization.

MECHANISM

The tympanic membrane (TM) is a tissue separating the external ear from the middle ear space. It is attached to a chain of small bones (auditory ossicles) located in the middle ear. The TM also serves as a barrier between the sterile middle ear space and the ambient environment.

Eardrum rupture may be caused by descending without equalizing the pressure in the middle ear, by a forceful Valsalva maneuver, explosion, a blow to the ear/head or acoustic trauma. Usually, it is accompanied with pain; rupture relieves the pressure (and pain) in the middle ear and may be followed by vertigo. There may be some bleeding in the ear canal.

Contributing factors include congestion, inadequate training and excessive descent rates.

MANIFESTATIONS

- | Ear pain during descent that stops suddenly
- | Clear or bloody drainage from ear
- | Hearing loss
- | Ringing in the ear (tinnitus)
- | Spinning sensation (vertigo)
- | Nausea or vomiting that can result from vertigo

MANAGEMENT

Most perforated eardrums will heal spontaneously within a few weeks. It may be necessary to treat nasal and sinus congestion. If the tear or hole in your eardrum does not heal by itself, treatment will involve procedures to close the perforation. These may include:

- | *Eardrum Patch:* An ENT specialist may seal the tear or hole with a paper patch. This is an office procedure in which an ENT applies a chemical to the edges of the tear to stimulate growth, and then applies a paper patch over the hole to provide a support structure for the growth of eardrum tissue.
- | *Surgery:* Large eardrum defects may be fixed by surgery (tympanoplasty). An ENT surgeon takes a tiny patch of your own tissue and plants it over the hole in the eardrum. This procedure is done on an outpatient basis, meaning you can usually go home the same day unless medical conditions require a longer hospital stay.

For an ENT referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

FITNESS TO DIVE

If your physician feels the healing is solid and there is no evidence of Eustachian tube problems, you can return to diving within several months. Chronic perforations that do not heal are a contraindication to diving.

PREVENTION

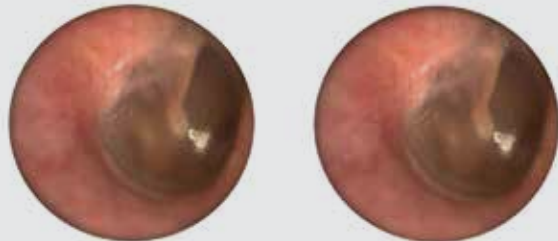
Do not dive with congestion. Maintain a comfortable rate of descent and equalize as needed.

The O'Neill grading system is a new way to grade the severity of middle ear barotrauma. It is simplified and is expected to provide more consistent diagnosis with sufficient details to direct the treatment.

O'NEILL GRADING SYSTEM

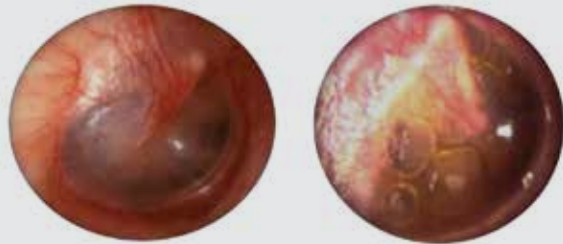
Grade 0 Eustachian Tube Dysfunction

- ▮ *Baseline* photo depicting anatomical appearance of the TM before exposure to pressure
- ▮ Symptoms with no anatomical change (no trauma) from *baseline*



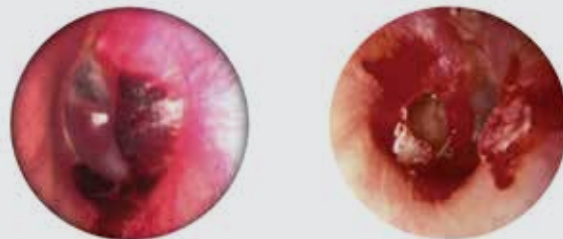
Grade 1 Barotrauma

- ▮ Erythema increased from *baseline*
- ▮ Fluid or air trapping (visible bubble) in the middle ear space



Grade 2 Barotrauma

- ▮ Any bleeding noted within the tympanic membrane or middle ear space
- ▮ Perforation



INNER EAR BAROTRAUMA (IEBT)

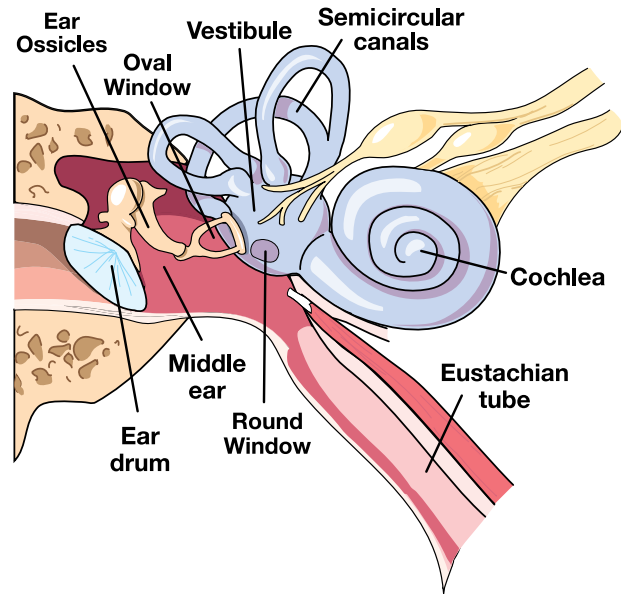
Inner ear barotrauma is damage to the inner ear due to pressure differences caused by incomplete or forceful equalization. A leak of inner ear fluid may or may not occur.

MECHANISMS OF INJURY

The inner ear is separated from the external world by the middle ear. It is the organ for hearing and balance. When the pressure in the middle ear space is properly equalized, the risk of inner ear barotrauma is extremely low.

If the pressure in the middle ear is not equalized during descent, the water pressure on the eardrum transfers inwards through the middle ear ossicles to the oval windows and the round window bulges outwards. The pressure itself may damage sensitive inner ear structures. If the pressure is excessive, either the oval window or, more commonly, the round window may tear and the inner ear fluid (perilymph) may leak into the middle ear (perilymph fistula).

The Valsalva maneuver increases the pressures in cranial tissues and circulation, which may transmit to the cochlear fluid causing an outward movement of the round window. Pressure waves alone can cause damage to the inner ear without window rupture. If the rupture occurs, the loss of fluid from inner ear leads to damage of the hearing organ and sometimes of the balance organ. If the leak is not stopped soon by spontaneous healing or surgical repair, permanent hearing loss may occur.



MANIFESTATIONS

Diver may experience:

- | Severe vertigo
- | Involuntary eye movement (nystagmus)
- | Hearing loss
- | Fullness of the affected ear
- | Ears roaring/ringing (tinnitus)

Symptoms of middle ear barotrauma are almost always present. Vertigo is usually severe and accompanied by nausea and vomiting. Hearing loss can be complete, instant and permanent, but divers usually lose just the higher frequencies. The loss becomes noticeable only after a few hours. You may not be aware of the loss until you have a hearing test.

MANAGEMENT

In case of vertigo underwater, abort the dive and obtain assistance to reach the surface safely. Begin surface oxygen if decompression illness is suspected. First aid providers should conduct a complete neurologic exam and note any deficits.

INNER EAR BAROTRAUMA OR INNER EAR DECOMPRESSION ILLNESS?

It is important to distinguish between these two conditions, because their treatments differ. The standard treatment for DCS of any kind is hyperbaric oxygen treatment in a recompression chamber; recompression or any pressure change is contraindicated when inner ear barotrauma is likely. While the symptoms are similar in both conditions, barotrauma is preceded by failed equalization of middle ear pressure and usually occurs at the beginning of dive, while DCS occurs due to failed decompression at the end of the dive.

DEFINITIVE TREATMENT

Seek an evaluation by a physician urgently to rule out DCS. If your physician determines it is not DCS, consult an ENT specialist with experience treating divers. For a referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

Avoid any exertion, middle ear equalization, altitude or diving exposure, sneezing or nose blowing. Do not take aspirin, nicotinic acid (vitamins), other vasodilators or anticoagulants. Conservative treatment includes bed rest in a sitting position and avoiding any strains that can increase intracranial or middle ear pressure. If symptoms do not improve, surgery may be necessary. Healing of the tear (fistula) usually occurs within a week or two. Hearing loss may become permanent.

FITNESS TO DIVE

Evaluation of fitness to dive requires an expert diving physician and depends on the degree of permanent damage as well as the probability of repeated injury.

PROGNOSIS

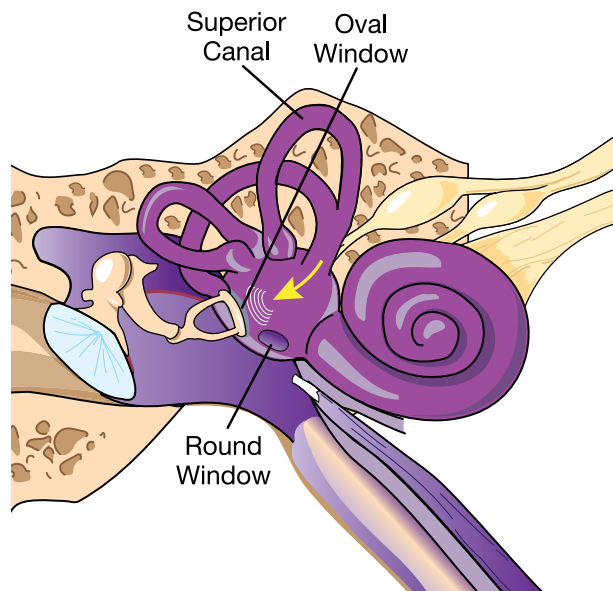
In many cases, complete healing occurs spontaneously. If fistula presents and does not heal soon spontaneously, surgery may be recommended. In some cases, the inner ear may be damaged permanently; the body may adapt to one side not working properly. If injury occurs to the other ear, the situation can be serious and may involve incapacitating balance problems.

PREVENTION

Learn gentle, but effective equalization techniques and avoid aggressive employment of the Valsalva maneuver. Do not dive when congested.

PERILYMPH FISTULA

A perilymph fistula is a tear in the round and/or oval window membranes through which inner ear fluid (perilymph) is leaking.



MECHANISM

Leakage of perilymph from the labyrinth may occur when the round or oval window is disrupted due to severe middle ear barotrauma or forceful Valsalva maneuver.

MANIFESTATIONS

The symptoms of perilymph fistula may include dizziness, vertigo, imbalance, nausea and vomiting. Some people experience ringing (tinnitus), fullness in the ears and many notice some hearing loss. Symptoms worsen with changes in altitude (elevators, airplanes or travel over mountains), weather changes and with physical exertion.

MANAGEMENT

This condition can usually be managed conservatively with absolute bed rest in the sitting position. Straining, sneezing, nose blowing, sexual activity, loud noises and middle ear equalizing should be avoided to prevent pressure waves in the inner ear.

The round window fistula often heals spontaneously within a week or two with this regimen, but if hearing loss progresses or the other features persist, it may be necessary to resort to surgery to repair the round window leak.

FITNESS TO DIVE

Even after the acute symptoms of an oval or round window fistula have resolved, the diver's future in diving is questionable. Flying should be completely avoided for several months to allow complete healing of the injury or the surgical repair.

For a referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

PREVENTION

Ensure the Eustachian tubes are functioning properly before diving by gently equalizing on the surface.

ALTERNOBARIC VERTIGO



Alternobaric vertigo occurs during descent, ascent or immediately after surfacing from a dive and is caused by unequal pressure stimulation in each ear.

STATISTICS

According to various sources, up to 25% of divers experience alternobaric vertigo at some time.

MECHANISMS

During ascent, air in the middle ear space expands, relative pressure increases, the Eustachian tubes open passively and gas escapes through the Eustachian tubes

into the nasopharynx. Occasionally the Eustachian tube may obstruct this flow of air, with subsequent air distension and increased pressure sensation in the middle ear cavity during ascent. If the obstruction is one-sided, and the pressure difference is greater than 60 centimeters of water, vertigo may occur as the pressure increase stimulates the vestibular apparatus. Usually it is relieved by further ascent, because the increasing differential pressure in the middle ear space forces open the Eustachian tube and vents the excess air. Contributing factors include middle ear barotrauma during descent, allergies, upper respiratory infections (congestion) and smoking.

MANIFESTATIONS

The symptoms of alternobaric vertigo may include disorientation, nausea and vomiting.

Note: The disorienting effects of vertigo while diving are extremely dangerous. The inability to discern up from down, follow safe ascent procedures, and the risks associated with vomiting pose a significant hazard to the diver as well as other divers in the water.

MANAGEMENT

Advice provided by Dr. Carl Edmonds about how to manage alternobaric vertigo during a dive:

“If a diver encounters ear pain or vertigo during ascent, he should descend a little to minimize the pressure imbalance and attempt to open the Eustachian tube by holding the nose and swallowing (Toynbee, or other equalization maneuver). If successful, this equalizes the middle ear by opening it up to the throat and relieves the distension in the affected middle ear.

Occluding the external ear by pressing in the tragus (the small fold of cartilage in front of the ear canal) and suddenly pressing the enclosed water inwards, may occasionally force open the Eustachian tube. If this fails, then try any of the other techniques of equalization described previously, and attempt a slow ascent.”

Uncomplicated cases resolve quickly within minutes upon surfacing. If symptoms persist, see your primary care physician or an ENT specialist. Do not dive if you have equalization problems.

Associated injuries include middle ear barotrauma and inner ear barotrauma; alternobaric vertigo may occur during descent or ascent, but is commonly associated with a middle ear barotrauma of ascent (reverse squeeze). Other conditions such as inner ear DCS or caloric vertigo (when cold water suddenly enters one ear) should be ruled out.

FITNESS TO DIVE

As soon as all symptoms and contributing factors have been resolved, a diver may return to diving.

PREVENTION

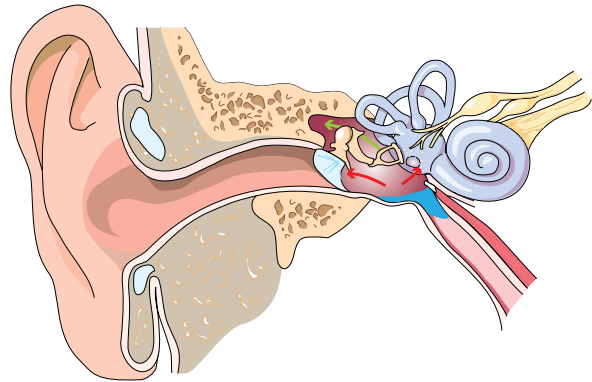
Take measures for the prevention of ear barotraumata. Avoid the unequal pressurization of the ear by avoiding tight-fitting wetsuit hoods or earplugs. Maintain good aural hygiene. Do not dive when congested or unable to equalize.

MIDDLE EAR BAROTRAUMA ON ASCENT (REVERSE SQUEEZE)

A reverse squeeze is barotrauma due to an inability to release pressure from the middle ear on ascent.

MECHANISMS

Pressure must be released from the middle ear as the diver ascends, or the expanding air will bulge and even rupture the eardrum. Normally, expanding air escapes down the Eustachian tubes, but if the tubes are blocked with mucus at depth (usually the result of poor equalization on descent, diving while congested or relying on decongestants that wear off at depth), barotrauma can result.



MANIFESTATIONS

- Pressure, fullness in ear
- Ear pain
- Vertigo

MANAGEMENT

While Diving: Sometimes one of the equalizing techniques used on descent will clear your ears on ascent. Pointing the affected ear toward the bottom may help, too. Ascend as slowly as your air supply allows. Usually, increasing pressure opens the Eustachian tube and relieves overpressure. However, in rare cases it may persist all the way up. In that case, you will just have to endure the pain to reach the surface. Notify your buddy and stay in close proximity.

First Aid: Nasal decongestant spray may help open the Eustachian tube. A physician evaluation is advised if you experience vertigo, protracted pain and fullness of the ears.

FITNESS TO DIVE

Repeated episodes require an ENT evaluation. For an ENT referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

PREVENTION

Prior to diving, try equalizing on the surface to ensure Eustachian tube function is adequate.

FACIAL BAROPARESIS



Reversible paralysis of the facial nerve due to increased pressure in the middle ear when ascending in an airplane or from scuba diving is called facial baroparesis.

Mechanisms

The facial nerve is a cranial nerve that controls the muscles of the face. On its way from the muscle to the brain it passes through the channel in the wall of the middle ear space. Normally, pressure changes in that space have little or no effect on the nerve.

In some people, the canal of facial nerve misses the bony wall and is separated from the middle ear cavity by a thin membrane only. If such a person experiences an overpressure in the middle ear equal or greater to the capillary pressure, circulation to the facial nerve stops, the facial nerve loses its functionality and facial muscle is paralyzed (facial baroparesis). This can happen while flying or diving. Fortunately, the pressure in the middle ear returns to normal soon after the exposure, restoring the circulation to the nerve and enabling its functionality. Facial baroparesis tends to recur with flying or repeated diving.

Manifestations

Symptoms include numbness, paresthesia, weakness or even paralysis of the face. Decreased sensation and a facial droop can be seen, generally on one side of the face.

Management

Usually, facial baroparesis is discovered postdive. Even when its duration is brief, and it resolves spontaneously, the patient should be evaluated by a physician to exclude other possible causes like stroke, infection, trauma or decompression illness.

In rare instances of protracted facial baroparesis, treatment may be necessary. There is experimental evidence that overpressure lasting more than 3.5 hours may cause permanent damage. Divers who continue to experience facial numbness and drooping should see a physician within three hours.

Fitness to Dive

This condition is self-limiting and resolves spontaneously within hours, but it can recur with diving or flying. Return to diving may be considered when symptoms have completely resolved and have been determined to be the result of facial barotrauma.

Prevention

Learn gentle, but effective equalization techniques. Do not dive with congestion.

TEMPORAMANDIBULAR JOINT SYNDROME (TMJ)

Temporomandibular Joint Syndrome is pain in and around the temporomandibular joint caused by prolonged gripping of a mouthpiece from a snorkel or scuba regulator.

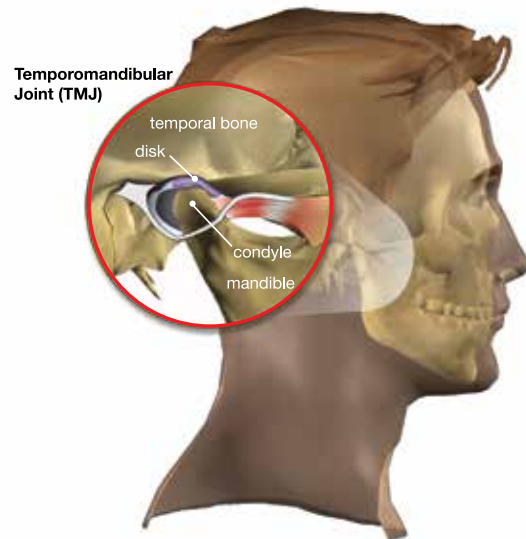
STATISTICS

It has been reported that TMJ occurs in 15-20% of snorkelers and scuba divers.

MECHANISM

TMJ is a chronic inflammation of the jaw joint just in front of the ear. The pain can be great enough to make holding the mouthpiece between the teeth difficult. The condition is exacerbated by local factors such as joint laxity, anatomical factors, capsular or muscular inflammation, or the type of mouthpiece used.

Diving-associated TMJ is thought to result from the forward posturing of the mandible by an ill-fitting mouthpiece and clenching of the mouthpiece especially with heavy regulators. Diving may aggravate preexisting TMJ. The pain is sometimes severe enough to cause divers to abort the dive. It can occur in novice divers who clench their teeth, sometimes with such intensity that they occasionally bite through the mouthpiece.



MANIFESTATIONS

- ▮ Pain in the TMJ and ears
- ▮ TMJ clicking or crepitus (cracking or popping sound)
- ▮ Trismus (inability to open mouth fully) and impaired TMJ mobility
- ▮ Dizzy spells (could be hazardous should it occur underwater)
- ▮ Masticatory muscle pain
- ▮ Stuffy sensation in the ears
- ▮ Eustachian tube dysfunction
- ▮ Headache and facial pain

MANAGEMENT

While Diving: Work to relax your bite, while retaining the mouthpiece in place. If unsuccessful, safely end the dive, surface and consider alternative mouthpiece options.

Definitive Treatment: If pain persists, a consultation with a specialist is suggested as solutions are highly individualized.

Treatment includes bite adjustment, management of dental problems and the use of orthodontic mouthpieces. Heat and anti-inflammatory drugs are helpful.

FITNESS TO DIVE

Return to diving is possible upon pain resolution. You must also be able to grip the mouthpiece without pain.

PREVENTION

Use only a mouthpiece that fits properly. Consider a customized mouthpiece. Correct contributing conditions such as dental problems, anxiety and teeth grinding (bruxism).

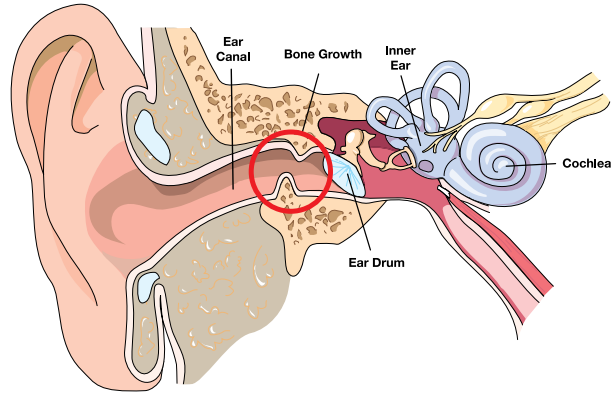
SURFER'S EAR

Surfer's ear is the narrowing of the outer ear canal due to an abnormal growth of bone caused by exposure to cold and wet conditions.

MECHANISM

The external ear canal is a tubular structure that conducts sounds and protects the middle ear.

Exostosis is a chronic condition characterized by narrowing of the inner half of the ear canal as a result of bone growth. The bony wall grows outwards slowly over a period of years in response to local irritation by cold water. These growths are called swimmer's nodes and are common in swimmers, surfers and divers. This condition is not related to infection, nor is it caused by infection; however, the narrowing of the ear canal may prevent water from draining out, which increases susceptibility to outer ear infections. The bony swellings continue to grow while there is a continued exposure to cold water (such as that found in seawater and outdoor swimming pools in temperate climates). Exostosis often occurs in outdoor enthusiasts in their mid-to-late-30s, but individuals who experience significant cold water exposure such as surfers, swimmers and divers can develop the condition earlier.



The narrowed ear canal is more prone to blockage by earwax or debris, and more susceptible to swimmer's ear (otitis externa). An exostosis on the floor of the ear canal can form a sump which retains moisture and is susceptible to infection. Exostosis is seen as a narrowing of the ear canal. The average ear canal is about 0.25 inches wide (7 millimeters). The bone growth may cause it to narrow down to 0.04 inches (1 millimeters). Early signs include water trapping in the ear canal after swimming. Debris trapping and infections may make surgery necessary.

MANIFESTATIONS

External ear infections and difficulty removing water from the external ear canal may be recurrent. Exostosis symptoms in advanced cases include a decreased hearing possibly combined with an increased prevalence of ear infections.

DIFFERENTIAL DIAGNOSIS

Other causes of external ear canal obstruction could include infection or earwax (cerumen) impaction.

TREATMENT

In case of decreased hearing or repeated infections, exostosis may be removed surgically.

FITNESS TO DIVE

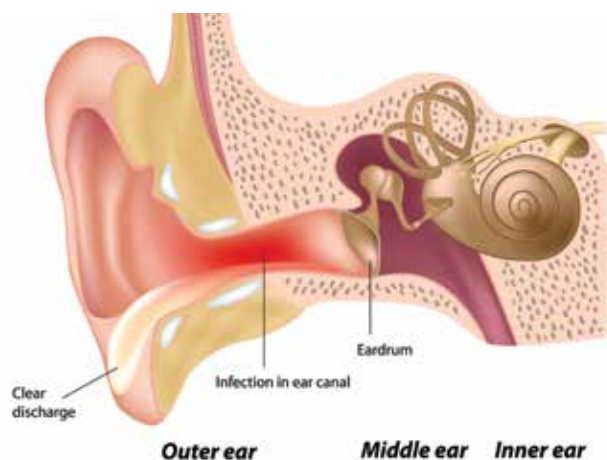
Exostoses do not affect fitness to dive unless they are occluding the ear canal or causing recurrent infection.

PREVENTION

- ❑ Wear a hood in cold water.
- ❑ After diving, rinse both ears out with freshwater to flush contaminated water and salt.
- ❑ If prone to ear infections, blow warm air into external canal using a hair dryer (take care to make sure the air is not too hot).
- ❑ If your ears have a natural tendency to build up a blockage of earwax, have them checked regularly, particularly before a prolonged diving trip.

SWIMMER'S EAR (OTITIS EXTERNA)

Acute inflammation or infection of the outer ear (pinna and ear canal) caused by prolonged exposure to wet and warm conditions is known as swimmer's ear.



STATISTICS

Otitis externa affects one in 200 Americans every year and is present in chronic form in 3-5% of the population. Swimmers, surfers and other individuals who are exposed to wet and warm conditions are at an increased risk.

MECHANISM

The external auditory canal is the tubular opening between the outside environment and the eardrum (tympanic membrane). It is covered by skin and secretes earwax (cerumen), which helps protect against infection.

Otitis externa, commonly referred to as Swimmer's Ear, is the acute inflammation or infection of the external auditory canal, resulting in ear pain and pus discharge.

Breakdown of the external ear canal's protective barrier leads to infection. Excessive moisture, mechanical trauma or underlying skin conditions are contributing factors. The bacteria normally found in the external ear canal often trigger the infection. With frequent immersion, water swells the cells lining the ear canal. Eventually, these cells separate far enough for the bacteria that are normally found on the surface of the ear canal to penetrate the skin, where they find a warm environment and start to multiply. Otitis externa is more likely to develop if the skin in the ear canal is already chafed and cracked by excessive moisture from showering or scratching. Bacteria or fungus from the water can easily invade damaged skin.

Seborrheic dermatitis, psoriasis, and excessive cleaning of wax from the ears that injures the skin lining the external ear canal may increase susceptibility of the ear canal to infection. Excessive debris or cerumen may trap water in the canal.

MANIFESTATION

The chief complaint is generally itching, often accompanied by pain, tenderness and swelling of the ear canal. If left untreated, the swelling can increase to include nearby lymph nodes and produce enough pain that moving the jaw becomes uncomfortable.

MANAGEMENT

First Aid

- ❑ Avoid getting in the water until after the problem clears up.
- ❑ Use a hair dryer to carefully dry the ear after you shower (take care to ensure the air is not too hot).
- ❑ In case of pain, over-the-counter pain medications can be effective. Examples of such medications include acetaminophen (Tylenol), ibuprofen (Advil or Motrin) or naproxen (Aleve). Read and follow all instructions on the label.

Treatment

Stop swimming and diving; schedule an appointment with your physician. Do not put anything in your ear unless instructed to do so. If you have diabetes or take medicine that suppresses your immune system, swimmer's ear can cause severe problems that require immediate medical attention.

It is important for your physician to rule out external ear squeeze, otitis media and mastoiditis (infection of the bone just behind the ear).

FITNESS TO DIVE

Return to diving is possible once your physician determines that the infection has resolved.

PREVENTION

Keep your ears clean and dry.

- ❑ Dry ears after swimming or showering with a towel, by tilting your head and pulling your earlobe in different directions while your ear is facing down.
- ❑ Refrain from putting objects in the ear canal, such as cotton swabs or your finger, or removing ear wax yourself—both can damage the skin potentially increasing the risk of infection.
- ❑ You can dry your ears with a blow dryer if you put it on the lowest setting and hold it at least a foot (about 0.3 meters) away from the ear.
- ❑ Talk to your doctor about whether you should use alcohol-based eardrops after swimming.

If you know you don't have a punctured eardrum, you can use over-the-counter eardrops or homemade preventive eardrops before and after swimming. This mixture of one-part white vinegar to one-part rubbing alcohol may help promote drying and prevent the growth of bacteria and fungi that can cause swimmer's ear. At the end of each dive day drip, five drops of the solution into each ear. Let it stay for five minutes before draining back out.

3

SYMPTOMS

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Recognition of potential problems is critical to incident prevention and management.

Pain is the most common symptom of ear injury but the most alarming symptoms are vertigo, tinnitus and acute deafness. All three symptoms may be caused by a variety of acute and chronic medical conditions, which affect fitness to dive. Acute onset of these symptoms in relation to diving may indicate inner ear barotrauma or decompression sickness and should prompt medical evaluation. Vertigo is often confused with dizziness, which has different causes and implications. Divers should be familiar with these symptoms so that they can recognize potential problems and intervene appropriately.

SEASICKNESS OR MOTION SICKNESS

Seasickness is a condition individuals may experience when on a moving platform. It involves a general feeling of illness, dizziness, nausea and vomiting. It is also called motion sickness. Passive motions disturb fluid movement within the labyrinth and affects one's sense of balance and equilibrium. It is exaggerated when the brain receives conflicting messages delivered from the eyes, muscles and joint sensors (proprioceptors). In a closed room, the view indicates that the surroundings are still, while the signals from the labyrinth indicate that the body is moving. Motion sickness can occur when travelling on a ship, plane, train, bus or car. Some people are more sensitive than others, but if the motion stimuli are strong and the exposure lasts long enough, nearly all individuals will experience it.

SYMPTOMS

The symptoms of motion sickness include dizziness, sweating, nausea, vomiting, and a general feeling of discomfort or illness. Symptoms can strike suddenly and progress from simply not feeling well to cold sweats, dizziness and vomiting. Motion sickness is more common in women and in children 2-12 years old. Individuals who suffer from migraine headaches are also more prone to motion sickness. Motion sickness lasts as long as the motion lasts. Once the motion stops, symptoms quickly subsides. Some people feel "sea legs" after a long sojourn at sea.



PREVENTION AND MANAGEMENT

If you know you have motion sickness or might be prone to it, consider this advice:

- *On a boat:* Stay on deck and focus on the horizon. Avoid inhaling exhaust fumes.
- *In a car:* Sit in the front seat. If you are the passenger, look at the scenery in the distance.
- Do not read in moving vehicles. Reading makes motion sickness worse.
- Avoid heavy meals prior to diving.
- Drink plenty of water.
- Avoid alcohol the evening before you travel.
- If possible, stand up. Sitting or lying down can make you feel worse.
- Eat dry crackers to help settle a queasy stomach.
- Avoid others who have become nauseous with motion sickness.

TREATMENT

Motion sickness can be treated with over-the-counter and prescription drug products.

- *Over-the-counter Products:* Antihistamines are commonly used both to prevent and treat motion sickness. A side effect of antihistamines is drowsiness, which is exaggerated when alcohol is consumed. Drowsiness may adversely affect diver safety.
- *Prescription Products:* The scopolamine skin patch (Transderm Scop) is a popular option. The patch is applied to the skin area behind the ear at least eight hours before exposure and can help prevent motion sickness for up to three days per patch. Scopolamine may cause dry mouth, blurry vision, drowsiness and dizziness. Patients with glaucoma, enlarged prostate and some other health problems should not use this drug. Be sure to tell your doctor of your existing health problems to help determine which drug is best suited for you.
- *Alternative Remedies:* Various alternative remedies have been promoted as being helpful in relieving or preventing motion sickness. In most cases, the evidence of efficacy is missing. However, if you have mild symptoms, you may try ginger or peppermint products to ease your symptoms without risking side effects.

VERTIGO

Vertigo is the persistent feeling of tilting, swaying, whirling or spinning motion of oneself or of the surrounding world when nothing is moving.

DESCRIPTION

Vertigo during or after diving is a common symptom of middle ear or inner ear injury. It is often associated with nausea and in severe cases vomiting. If vertigo happens underwater, the diver may not be able to tell which way is up; panic and vomiting may cause choking and drowning. On land, the patient may not be able to sit or stand

There are various causes of vertigo. In diving, it is most often caused by inner ear barotrauma. It can also occur from stimulation of one side and not the other, such as when the pressure difference in only one ear equalizes (alternobaric vertigo) or when cold water enters one ear but not the other (caloric vertigo). This type of vertigo disappears as the condition equalizes and leaves no lasting effects except that the associated disorientation, nausea and vomiting while underwater may contribute to diving accidents.

Vertigo is an acute symptom of vestibular injury that may be associated with other symptoms, some of which may become chronic. Symptoms may include imbalance and spatial disorientation, vision disturbance, hearing changes, involuntary eye movement (nystagmus), cognitive and/or psychological changes, among others.

DIFFERENTIAL DIAGNOSIS

Vertigo is not the same as dizziness, lightheadedness or unsteadiness. When you're dizzy, you may feel lightheaded or lose your balance. If you feel that the room is spinning, you have vertigo.

For vertigo, differentiate between inner ear decompression sickness (DCS) and inner ear barotrauma.

GENERAL GUIDANCE

- Vertigo occurring briefly during or after a dive and resolving spontaneously requires evaluation of Eustachian tubes before resuming diving.
- Persistent vertigo is a sign of serious conditions and requires urgent evaluation by an ENT specialist. For an ENT referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.
- Severe persistent postdive vertigo is an emergency.

FITNESS TO DIVE

Damage to vestibular organs by DCS, barotrauma or by acoustic shock may be permanent. In case of single-ear injury, vertigo may go away in two to six weeks, because the brain learns to compensate and ignores the side that is damaged, but the canal will not heal. The diver will have difficulties maintaining balance in the dark when deprived of visual clues. Damage to both vestibular organs is debilitating and may make certain life activities challenging or impossible (like driving a car).

Persistent or recurrent vertigo, even if controlled by medications, is disqualifying for diving.

Return to diving after inner ear barotrauma or decompression sickness should be evaluated on an individual basis depending on the extent of permanent injury of inner ear organs.



TINNITUS (EARS RINGING)



Tinnitus is noise or ringing in the ears.

DESCRIPTION

Tinnitus is the sensation of an external sound that is not actually present. Tinnitus (ears ringing) affects approximately one in five people and can be caused by many medical conditions.

POSSIBLE DIAGNOSES

It is important to find the underlying cause of the tinnitus. Acute tinnitus occurring during or after diving is likely related to ear barotrauma or inner ear decompression sickness. If associated with diving, your physician must determine whether it is barotrauma or inner ear decompression sickness, because the treatments are not the same and administering the wrong one can actually be harmful.

Other possible causes of tinnitus include:

- | Concussion
- | High-intensity noise or blast
- | Infection
- | Ear infection (Otitis media)
- | Tumor
- | Temporomandibular joint dysfunction (TMJ)
- | Foreign body in the ear
- | Vascular abnormality
- | Meniere's disease
- | Hypertension
- | Migraine
- | Some medications (including aspirin and quinine)
- | Various poisonings (such as carbon monoxide, nicotine and heavy metal)

FITNESS TO DIVE

If tinnitus is not related to diving and the underlying problem is not a contraindication for diving, there is no reason to curtail diving because of tinnitus itself.

HEARING LOSS/DEAFNESS



Hearing loss/deafness is the partial or complete loss of hearing from normal baseline.

DESCRIPTION

Complete or partial hearing loss can occur for a variety of reasons. There are several diving-related causes including barotrauma, decompression sickness (DCS) and damage to the inner ear.

Hearing loss can be classified as conductive or sensorineural.

- Conductive hearing loss involves the ear canal, eardrum and tiny bones of the middle ear ossicles; these anatomical components mechanically conduct sound to the inner ear where electrical signals are generated.
- Sensorineural hearing loss involves the brain, the eighth cranial nerve or the inner ear.

POSSIBLE DIAGNOSES

There are many causes of hearing loss including infection, blocked ear canal, barotrauma, drugs, trauma, round or oval window rupture, stroke, Meniere's disease, noise and medications.

FITNESS TO DIVE

Although uncommon, dive-related permanent hearing loss resulting from ear barotrauma or inner ear DCS is possible. If the injury causes permanent unilateral (one ear only) hearing loss or impairment, most physicians will recommend against a return to diving. This is often recommended because if subsequent diving resulted in injury to the remaining functioning ear, the individual may experience permanent bilateral hearing loss. This recommendation applies to all monaural (one-sided hearing) individuals, regardless of the cause of unilateral hearing loss or impairment.

An additional population for whom diving is often discouraged or extreme caution is advised includes those who have undergone cochlear implant surgery, ossicle surgery or tympanic membrane repair (myringoplasty.) Diving places individuals with this medical history at risk of damaging the surgical repair resulting in hearing loss. For divers who have undergone such procedures or suffered permanent hearing loss from ear barotrauma, extreme caution is often recommended and close consultation with an ENT physician prior to diving is highly advised. For a referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

It is important to mention that bilateral hearing impairment (either congenital or acquired) does not necessarily medically preclude someone from diving. However, in cases of bilateral hearing impairment, a diving environment may pose potential difficulties with surface communications, both with other divers and with crew members. Obstructed communications in cases regarding boat traffic, diver recall and other unforeseen circumstances may result in delayed emergency response, injury or death.

4

HYGIENE

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Water sports expose our ears to a variety of potentially damaging conditions.

People are aware of their ears in many ways. They take prominent place on the head and thus aesthetic concerns sometimes compete with health concerns. Natural protection of the skin of ear canal involves a wax, which in some cases may become a health nuisance and cause real medical issues. Some people perceive the wax as a hygiene issue and overzealously try to get rid of it. This can cause problems of its own.

Outdoors activities, especially water sports, expose ears to cold, wet and overly warm conditions, which can damage ears. There have been many proposed commercial solutions that supposedly will mitigate the risk of ear injury or damage. Unfortunately, few such products have been tested by health authorities. In this chapter, we will discuss aural hygiene and medications as well as earplugs (a device we do not endorse for divers) and ear ventilation tubes.

AURAL HYGIENE

Having a clean ear canal is important for divers. In extreme cases, earwax can form a plug and trap air between itself and the eardrum, which can cause an “explosive” tympanic membrane perforation that tears outward instead of the more common inward perforation.

In addition, an earwax plug could prevent water from chilling one ear, while the other is naturally chilled by water filling the ear canal. This temperature differential between the two ears causes caloric vertigo.

Finally, a wax plug may prevent proper drainage from the ear canal. The retained moisture may cause softening of the skin and pave the road to infection.

So, how should you clean your ears?

THE WRONG WAYS

Avoid cotton-tipped swabs. The cotton-tip applicators may push wax deeper into the ear making wax removal more difficult. In addition, the ends of the cotton tip applicators can detach and be left in the ear canal. In a few days, this usually results in a severe ear canal infection. If this happens, the cotton should be identified and removed by a qualified physician. Do not ever attempt to do this yourself; you could tear your eardrum.

HANDLING INSECT INFECTIONS

Occasionally, people who sleep outdoors or who live in warm areas can get insects in their ears. An insect in the ear can be an alarming experience. For removal, you'll need a cool head, especially if the insect is still moving or stinging.

In the field, you can use rubbing alcohol, which rapidly drowns the insect and cleanses the ear canal. It is also acceptable to use a bulb syringe, filled with a warm soapy water (such as baby shampoo) and hydrogen peroxide solution. If this is unsuccessful, get medical help right away. The preferred method is removal by a qualified physician with special instruments and a microscope.

THE RIGHT WAY

So, how should you clean your ears? When you bathe, occasionally wash your ears with a bulb syringe filled with warm soapy water and hydrogen peroxide solution. On a diving trip, use a mixture of half white vinegar and half rubbing alcohol after a day's diving: this serves to cleanse and dry the ear canal, as well as change the pH balance to make the area less prone to bacterial infection. This can also help prevent swimmer's ear (otitis externa).

If you have a hard time getting water out of your ears, try using a hair dryer. It's a good idea to lift the ear upward and back to straighten the ear canal and then to blow warm dry air into the ear canal for five minutes. Take special care to ensure the air is not too hot.

Just remember that ear care is as basic and important as the care of any of your other diving equipment.



EARPLUGS



Earplugs are devices that occlude the external ear canal. They are primarily used to block the pressure of water on the eardrum. Generally, earplugs should not be used by divers.

PROCEDURE IN PRACTICE

Standard solid earplugs create an air space that cannot be equalized while diving, making them generally unsafe for diving; however, some divers use earplugs in special situations.

The main concern is that water pressure could wedge the plug into the ear canal. If this occurs, there is risk of external ear barotrauma. To address these concerns, some manufacturers promote the vented earplug, which has a small hole for venting between the water and the ear canal. The holes typically have a valve for pressurization without letting water enter the ear canal.

Most manufacturers of vented plugs emphasize the ease with which their products equalize and recommend that divers clear their ears frequently while wearing the earplugs to maintain proper pressurization. However, these assertions have not been independently tested. There is just not enough data or evidence to recommend the use of plugs for divers. The risks of complications underwater from malfunction or removal of an earplug are real and can potentially place the diver at increased risk for injury.

EARDROPS



Eardrops are a solution of medications intended for application in the external ear canal.

PROPHYLACTIC USE OF EARDROPS

For most divers, eardrops are not necessary after diving. The purpose of most eardrops is to prevent external ear canal infections (known as otitis externa or swimmer's ear). Infections of the ear canal are associated with persistent moisture as well as local skin trauma, which can result from inserting cotton swabs or other objects into the ears that can damage the thin skin lining the ear canal. As DAN Medics are fond of saying, "Don't put anything smaller than your elbow in your ear." Persistent moisture and local skin trauma can enable bacterial overgrowth and infection.

Eardrops are formulated to help dry the ear after exposure and lower the acidity (pH), making the external ear canal an unfriendly environment for bacterial or fungal colonization and infection. Common ingredients

include acetic acid (the active ingredient in vinegar), boric acid, aluminum acetate, sodium acetate, isopropyl alcohol and glycerin. The acids alter pH, which retards bacterial growth; aluminum acetate and sodium acetate are astringents, which shrink tissues. Isopropyl alcohol helps dry the tissues, and glycerin may help lubricate the skin to prevent excessive drying.

For divers plagued by swimmer's ear, gently rinsing the ears with freshwater after each dive may help. Drying the ears with a hair dryer may also be helpful, but take care to ensure the air is not too hot.

THERAPEUTIC USE OF EARDROPS

Eardrops can be prescribed by your physician to treat infection or inflammation of the external ear canal. These drops may contain antibiotics and/or steroids.

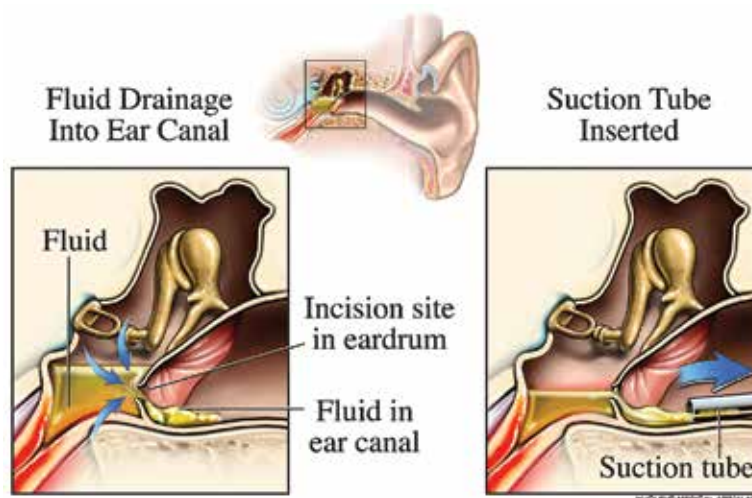
Note: It is important to never put drops into the ear canal if eardrum rupture is suspected. Normally the eardrum serves as a barrier to the middle ear space. If ruptured, contamination or medications harmful to the inner ear can gain access.

FITNESS TO DIVE

Prophylactic ear drops are used to prevent external canal infections during repetitive multiday diving. If you feel ear pain, you should stop diving and have your ear evaluated. Divers diagnosed with an ear infection or ear injury should not dive before fully healed and cleared by a physician.

EAR VENTILATION TUBES

Ear ventilation tubes are small tubes that are surgically inserted through the eardrum to enhance drainage and equalization.



PROCEDURE

Small ventilation tubes may be surgically inserted through the eardrum (tympanic membrane) to help interrupt a cycle of repetitive middle ear infections. The infection process causes swelling and inflammation in the Eustachian tubes, preventing proper drainage; the ventilation tubes enable drainage from the middle ear until the Eustachian tubes normalize. Inserting the ventilation tubes through a small incision in the tympanic membrane (myringotomy) usually corrects this situation.

The tubes are not meant to be permanent implants and usually fall out on their own or are removed by the physician. The small incision usually heals shortly after the tubes are removed. In rare cases, a small hole may remain if the tubes are left in for a long period of time. This situation can be tested for and is best addressed by your physician. It is unlikely that the tubes are still in place after more than a few years.

FITNESS TO DIVE

Diving is not recommended while the tubes are in place as they will allow water to enter the middle ear, risking vertigo and infection. After the ventilation tubes are removed or come out, adequate time for healing must be allowed (at least six weeks). Middle ear and Eustachian tube function must be confirmed as normal before diving is considered.

A bigger problem may be scarring of the Eustachian tubes as a result of the chronic ear infections. This can make ear equalization difficult for the diver. Currently, there is no surgical procedure that can correct a partially obstructed Eustachian tube.

Children and adults alike need immediate attention for symptoms of middle ear infection and barotrauma. Symptoms may include, but are not limited to pain; ringing or roaring in the ears (tinnitus); a sensation of partial, decreased or muffled hearing; and drainage from the ear canal.

5

MEDICAL CONDITIONS

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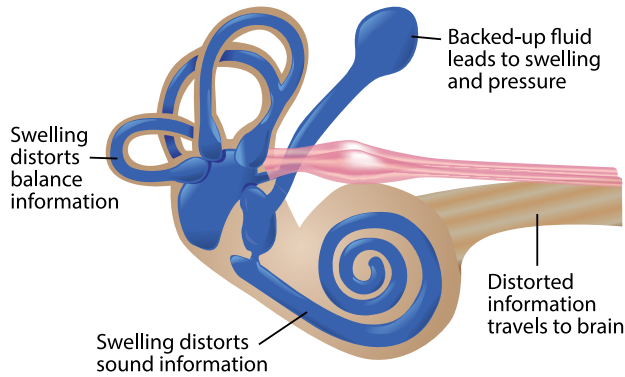
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Call DAN.

Your ears and ability to equalize may be affected by various diseases. In this chapter, we have provided information about two conditions divers often ask about: Meniere's disease and deviated nasal septum. If you have questions about specific conditions that are not highlighted in this book, do not hesitate to contact the DAN Medical Information Line at +1-919-684-2948.

MENIERE'S DISEASE

Meniere's disease is a disorder involving recurring episodes of vertigo, which may be associated with vomiting, fluctuating hearing loss, ringing in the ears (tinnitus) and a sensation of increased pressure in the ear.



DESCRIPTION

This chronic condition affects the inner ear. It results in vertigo and hearing dysfunction. A disabling episode of vertigo may involve severe nausea and vomiting. In addition, Meniere's Disease can muffle or impair hearing. Individuals may also experience a sensation of increased pressure in the ear. Migraine headaches have also been linked to this condition.

MANAGEMENT

Treatment focuses on symptom management. Medications are used to control the vertigo and associated nausea and vomiting. Diuretics are sometimes used to help regulate the excess volume of endolymph (fluid contained in the inner ear) that is associated with Meniere's disease.

An ENT physician consultation is recommended as surgical procedures may help achieve relief. For a referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.

FITNESS TO DIVE

This condition is variable. It may spontaneously resolve or progress to involve the other ear. If you are at risk of experiencing disabling symptoms such as vertigo, disorientation, nausea or vomiting, you should not dive; should these symptoms occur underwater, they may lead to panic, choking and even drowning. In addition, these symptoms may be confused with dive-related injuries, such as inner ear barotrauma or inner ear decompression sickness.

DEVIATED SEPTUM

A deviation of the wall separating the two nostrils that may lead to obstruction of the nasal passages and sinuses is a deviated septum.

DESCRIPTION

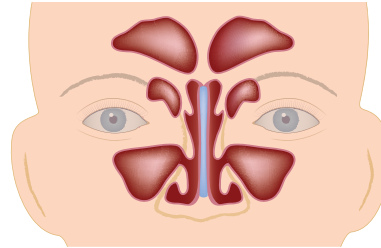
The nasal septum is the wall that separates the two nostrils. When the septum is displaced or curved, it is known as a deviated septum. Generally this condition is of little or no consequence and may go unnoticed; affected individuals may experience difficulty equalizing. A deviated septum may be present at birth (congenital disorder) or result from trauma to the nose. It is often discovered during a routine physical exam. This condition has been linked to sinusitis as well as barotrauma (sinus and middle ear).

TREATMENT

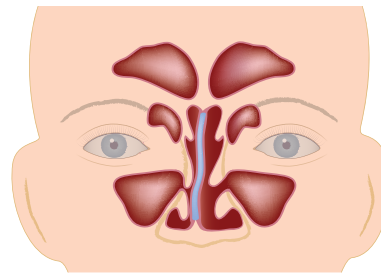
Decongestants may provide some relief. Surgical correction (septoplasty) is typically reserved for those with symptoms such as snoring, nasal obstruction, recurrent sinusitis or sleep apnea.

FITNESS TO DIVE

There is no contraindication to diving with an asymptomatic deviated septum. If recurrent infections or difficulty equalizing occurs, an ENT consultation is suggested. For a referral in your area, email medic@dan.org or call the DAN Medical Information Line at +1-919-684-2948.



Normal



Deviated Septum

DAN HEALTH & DIVING RESOURCES

HEALTH & DIVING REFERENCE BOOKLETS

Generated from more than 30 years of research and medical data analysis, each reference booklet provides extensive insight into a single topic critical to diver health and safety.

For more information about DAN's Health & Diving initiative, visit [DAN.org/Health](https://www.dan.org/Health).



HAZARDOUS MARINE LIFE:

While exciting, observing marine life in their environment comes with a risk. Injuries, though rare, may occur as a result of an uninformed swimmer or diver's actions. The Hazardous Marine Life reference booklet examines the most common hazardous marine life that water enthusiasts may encounter and introduces the mechanisms of injury, techniques for injury prevention and application of first aid.



THE HEART & DIVING:

Cardiovascular health is an essential component of scuba diving safety. However, heart health may deteriorate gradually as divers age and can put divers at risk. This booklet covers the basic concepts of normal heart functions in physical activities, physical fitness requirements of diving, how heart diseases may affect dive fitness and how divers can maintain their fitness capacity.



DECOMPRESSION SICKNESS:

Decompression sickness (DCS) is an unwanted outcome of diving. Measures to mitigate the risk of DCS have to be a part of every dive. This booklet provides updated concepts of causes and mechanisms, typical manifestations, standard management and prevention of DCS.



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