Otitis Externa

Outer Ear Inflammation and Infection in Freediving

Nora Galgoczy, July, 2016.

ABSTRACT

This paper outlays the phenomena of Otitis Externa with particular regards to freedivers, explains contributing factors and recommends means of preventative measures.

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I. Introduction

Since I was born, my ears were exposed to water on a daily basis. My Dad

insisted on me building up a high level of comfort in the water from day one hence I was submerged under water in the bath, in swimming pools, lakes and the sea since I was a little baby. As I grew up, I was always in the water with my ears submerged whenever I had the opportunity, either taking a bath, swimming or snorkeling. This involved public swimming pools and lakes/seas/oceans in Central, Eastern and Western Europe, Africa and the USA. For 28 years I had not once had a problem with my ears.

Then I moved to Thailand and started freediving. Since the first time I have dipped into the Andaman Sea (2 years ago) I encountered a large number of ear canal inflammations/infections – mild and severe, some lasting only a day or so, others lasting 6-8 weeks. Sometimes it was just a slight itch and a weird numbness I felt. Other times I was in agony from the pain in not only my ears but in my jaw as well, not being able to sleep or eat for days. My ears were swollen, so I didn't hear properly, my vision was impaired, I had a constant headache, I lost balance, I was sick and just generally miserable especially for having to stay out of the water.

Many freedivers are affected by **Otitis Externa** (referred to as **OE** hereafter) as during practicing freediving we encounter many of the possible causes on a very frequent basis. When we do incur an ear infection, we do then find it harder than other people to follow the doctors' advice "Stay out of the water". Though we really should.(51),(52)

Now, after two years of research and trying different methods, treatments and medication, I finally seem to have found a simple but effective way of managing the problem, and OE no longer interrupts my freediving schedule.

In this paper, I summarize the knowledge and experience I obtained during this time and share useful information on how to manage OE.

II. The Ear and What is Otitis Externa

So first, let’s go into some details on how our ears are built, what is OE and it’s possible causes.

The Ear

Our ear can be separated into the parts of the inner, middle, and outer ear. We have the nerves and organs responsible for balance and hearing in the inner ear, which are connected to the eardrum through the bones of the middle ear. The eardrum separates the middle from the outer ear. The outer ear consists of the earlobe (pinna) and a short tube (ear canal).(1)

The outer half of the ear canal is made up of firm tissue and a layer of skin with many hair follicles and glands. By contrast, the inner half of the canal is bony with much thinner skin almost without any hair follicles and glands.
The skin of the ear canal is lubricated by earwax, a water repellent substance consisting of glands’ discharge and the regularly shed and replaced skin cells. This coating is one of the most important protective mechanisms of the ear. Earwax prevents the skin from excessive moisture and protects from many ear canal infections by its mild antimicrobial properties.
(2),(3)
The skin layer of the ear canal slowly (about 1.5mm/month) travels outwards from the eardrum carrying shed skin fragments, cerumen and other debris. This process together with the jaw movement also contributes to the ear’s protective mechanism.(4),(3)

What is an External Ear Infection (OE)?

An outer ear infection can be described as an inflamed part of the skin layer within the ear canal. It can be acute (short-term) or chronic (lasting 3 or more months) and doesn’t necessarily involve microorganisms invading your body. Inflammation may be caused by mechanical means (for example abrading the skin by scratching), chemical substances (like hair spray getting in the ear canal

causing irritation) or biologic (bacterial and fungal) agents.
Most commonly Pseudomonas Aeruginosa and Staphylococcus Aureus are the responsible species causing a bacterial external ear infection. Fungal infection is less common (12% of ear infections) and in 90% of the cases it is caused by Aspergillus, and in the rest by Candida(5).
The infection is usually more persistent in cases due to bacteria or fungi.
Abrasion of the skin by scratching or irritation caused by chemical substances would normally be healed by the ear's natural protective mechanism – although, these can open the door wide open to bacteria and fungi.(3),(5),(4)

When you experience Otitis Externa, signs and symptoms may include:

- Swelling, redness of the ear canal that usually comes with itching and/or pain;
- Extensive, greenish/yellowish discharge/pus (sometimes foul odor), which, together with swelling, can lead to hearing loss and the ears feeling full;
- Tenderness in the earlobes;

– Unpleasant enough state to be in through our day-to-day lives, not to mention freediving.(1),(3)

III. Possible Causes/Contributing Factors

1. Weather conditions

Ear infections most commonly happen due to increased levels of temperatures and humidity, and/or activities involving ears submerging under water (yes,

basically freediving in Thailand). In such environment, the warm, moist and dark ear canal can provide an ideal breeding ground for bacteria and fungi.
So this is something to be aware of when you are going on a freediving holiday to a country with tropical climate.(1),(3)

2. Water sports
Prolonged exposure to water can remove the protective layer, allowing the skin to soften and absorb moisture. This leads to swelling and obstruction of the glands, thus preventing replacement of the earwax while causing irritation/itching.
Us, freedivers often spend extended times in the water and this phenomenon most of us are familiar with.(3)

3. Scratching
Scratching will not only further irritate the area, but will also harm the protective layer/skin of the outer ear, providing easier access to the ultimate culture environment that lays below/within. Also, any germs on our hands will just get a free ride to “heaven”.(53)

4. Ear swabs
You can also trap bacteria in your ear by using cotton buds. Pushing the swab inwards goes against the natural protective lining migration of the ear (covered above) and causes shed skin fragments and earwax to build up. This will in itself promote a better environment for fungi and bacteria growth and also can trap even more water when ears are submerged, making it more difficult for them to dry out. Abrasions on the skin caused by cotton swabs have the same effects as scratching.
Also, pieces of cotton can remain in the ear and become a water trap – and so ground to bacteria/fungi.(1),

5. Over cleaning
Excessive cleaning of the ears removes the natural protective layer from the ear canal making it more susceptible to infections.
Cleaning the ear with chemicals can also irritate the skin resulting in over sensitivity. (53)

6. Surfers’ ear
An abnormal bone growth within the outer ear, commonly known as “surfer's ear” is caused by repeated exposure to cold water and wind. This is also the case with freedivers practicing in colder climates on a regular basis, we just usually spend less time in the water when it is windy but also spend more time submerged in the cold water. Such circumstances stimulate bone growth that narrows the canal and blocks the eardrum, which makes water and earwax to be easily trapped.(6)

7. Higher water temperatures

The most common pathogens of external bacterial ear infections are Pseudomonas Aeruginosa and Staphylococcus Aureus, and for fungal infections are Aspergillus species and Candida. Their ideal temperatures for rapid growth are 25-42˚C, 30-37˚C, 30-35˚C and 33˚C respectively and still growing at slower rates outside these ranges(9),(10),(11),(12),(13). The seawater temperatures at tropical destinations are most commonly well within these ranges thus providing a growth-friendly environment to species causing ear problems. It would seem reasonable to think that this is where we pick up the bacteria or fungi from which then can result in OE.

In fact, most of such bacteria and fungi already live in our ears before we enter the water. Warmer water is only a contributing factor, not the source. It dissolves cerumen easier/faster and also causes more swelling of the cells lining the ear canal than cold water, allowing triggers of OE to get under the skin easier. Warm water does provide a better growth environment, therefore, it can encourage growth more than our ears' natural defense mechanism is used to deal with.(7),(8),(9),(10),(11),(12),(13)

8. Saltwater

After freediving in the sea, salt crystals are formed from the water drying in our ears. Such residue can retain moisture and keep the ear canal wet.(54)

9. Swimming pools

Pool sessions are important parts of our freediving training, although exposure of the ears to swimming pool water with chlorine content can cause irritation of the skin in the ears. Although, the problem is not the chlorine itself:

Chlorinated water reacts with organic materials from people (such as urine, sweat, cosmetics or ear wax) and as a result, trichloramines are released that causes irritation of the skin. Worsening the situation when chlorine is chemically bonded with such contaminants it will be unavailable to neutralise other germs. Also, chlorine in the water can cause the protective cerumen layer in the ears to break down, making them more susceptible to infections.(14),(15),(16)

10. Allergic reaction

Apart from infections, OE may also be caused by an allergic reaction to something that comes into contact with the ear drum (tympanic membrane). Often, the cause is never found, but commonly, hair sprays, shampoo, and other domestically used products are responsible.(17)

11. Air conditioner

Air-conditioning units on the inside are dark, moist and warm, just like our ears, only without the natural self-cleaning mechanism. If the unit is not maintained on a very regular basis it can provide an ideal environment for substantial growth to fungi and other bacteria, which then will be circulated in the air around

us.(55),(56),(57)

12. Increased susceptibility due to underlying conditions
People with underlying conditions, such as asthma, psoriasis, rhinitis (allergic) or eczema are significantly more likely to develop OE, compared to others.
Systemic conditions which lower the body's resistance, such as anemia, vitamin deficiencies, diabetes, and endocrine disorders will also make the ears more susceptible to ear infections.
The cerumen's acidity plays an important role in protecting the ears from infections. Certain conditions such as diabetes or acid reflux will result in a change of the earwax' PH level impairing its effectiveness against bacteria and fungi.(18),(2),(17),(1)

IV. How are Freedivers affected in particular?

From the non-exhaustive list above we can see how much we are exposed to a potential ear infection by many of the possible causes being directly related to freediver activities. This does not necessarily mean that we'll all encounter OE if we are freediving – many apneists never experience the problem. However if it does happen it is important to know what we can expect and the risks of ignoring or mistreating it.

As a freediver, my ears are one of the most precious pair of organs I have. I need them to be "tip-top" in order to do my dives.
One of the most common problems for freedivers at a depth session is the inability to equalise. Equalisation issues occur due to many different factors including lack of relaxation, built up mucus, inflexibility or the wrong techniques applied. In the presence of an ear infection it is much less likely for a freediver to

be able to equalise safely and effectively:

- Experiencing pain or any discomfort during equalisations or even in-between will **adversely affect relaxation**;
- Inflammation in the ears often affects the eardrum that can lose its flexibility to some extent – this will increase the **risks of a punctured/ruptured eardrum**;
- Built up wax and dirt can create an extra air pocket in the outer ear that **we cannot equalize**;
- Swelling in the ears can also lead to a complete blockage of the ear tunnel that is then **difficult or impossible to equalize**;

(58),(59),(60)

But forget about equalisation: if we intend to avoid worsening the problem we can't even go in the water, not even for a shallow or a pool session.

In many cases, OE goes away by itself without any treatment if we just stay out the water for a few days.

Other cases we will need ear drops, antibiotic tablets and/or other medical treatment if we don't want to encounter more serious consequences. If the OE is mistreated or left untreated it can lead to a more severe case that also means more severe symptoms, and the infection may become acute (lasting several weeks) or chronic (lasting several months).(19)

Middle Ear Infection (Otitis Media)

A middle ear infection is usually due to some kind of respiratory infection such as a flu where germs growing in the nose and sinus cavities travel through the Eustachian tube to the middle ear. In general, OE does not lead to a middle ear infection. Eardrums under ordinary circumstances have the ability to stop bacteria and fungi to progress further from the ear canal.

However, exposing them to pressure as a freediver does is not an ordinary circumstance. When the outer ear is infected, the eardrum is less flexible thus due to frequent equalizations and built up pressure risks of a punctured/ruptured eardrum are higher. If that happens, the outer ear infection will have an easy way to the middle ear.

Also, many freedivers have experienced ear barotraumas that have left the eardrums punctured/ruptured/scarred. Even the tiniest whole on the eardrums are big enough to let fungi or bacteria through which then will infect the middle ear. With an already damaged eardrum that isn't entirely healed yet, we can

easily get a middle ear infection even without having the advance warnings of an OE.

Wet Equalisation maneuver is another way of increasing risks of Otitis Media and inner ear infection. This technique involves flooding air spaces (that would otherwise have to be equalised) with water. Since fluid isn't compressible, we can avoid having to equalise during descent. However, allowing contaminated water into the body where our defense mechanism is not prepared to fight such bacteria and fungi will most likely to lead to Otitis Media.

In comparison to OE, a middle ear infection takes pain to a whole new level and is extremely hard to get rid of.(20),(1),(21)

V. Management of Symptoms

There are many different deciding factors as to what is the right treatment for an OE. Determining the cause is often crucial to ensure we're not making things worse. For example, eardrops that heal an ear infection in one case can make it much worse in another.
Seeing a reliable specialist is the best choice in many cases. However, it isn't always an option or necessary.

What can you do?

1. Avoid contributing factors/ treat underlying conditions

The number one thing you'll need to do is to stop making the situation worse. Many of the cases can be sorted just by letting our ears' natural cleaning mechanism work. To enable that, avoid any contributing factors that can make it worse (avoid getting them wet, stop using air-conditioner, resist the urge to scratch it, clean it extremely gently if you must, etc.). Many times only by doing this your ears will get better in a day or so.
If there is any underlying condition you know of causing it, treat that first.

Do not underestimate the effects of contributing factors. If you do not avoid them for the time of your healing, usually your ears will not recover entirely, no matter what treatment you undertake.

2. Remove the irritant/ allergen

Sometimes stuck dirt itself can cause the ears to block, and on occasions, it is the excess earwax being produced as a response to debris. If we are certain that the blockage is due to dirt or excess cerumen, we can remove it ourselves by using a syringe filled with clean water to rinse it out (aural toileting). A small amount of betadine or another antiseptic can be added, but to avoid further irritation of the already upset skin, the use of hydrogen peroxide isn't recommended.

Over-the-counter earwax removers can be effective but be sure not to over-use them as they can lead to complete drying out of the ears.
Tough, if you have a reason to suspect any rupture/puncture on your eardrums, you should avoid any flushing or the usage of any eardrops – go straight to see a doctor.

If you choose to apply alternative solutions, be sure you research them properly. Many times these remedies not only ineffective but make things worse (for example ear candles). Whatever procedure you apply, do not overdo it and make sure you do not cause any damage to your skin by doing so.(22),(23)

3. Reduce inflammation

On occasions, the already existing inflammation disables the ear to get better by blocking any debris/earwax/liquid to be removed or drain from the ear.
To treat this, we can take anti-inflammatory medication (such as Ibuprofen).

If symptoms persist or get worse, go and see a reliable specialist.

What can your doctor do?

Usually, only physical examination including otoscopy will be sufficient for your doctor to diagnose OE.
In case the ear canal is not visible aural toileting and wick therapy are common practices.(24),(25),(26),(60)
Where a more severe condition or fungal infection is suspected, or symptoms persist for a longer period, standard laboratory testing may take place (including blood, urine, and discharge sample test).(5),(26),(60)

Your doctor then will prescribe you the medication they believe best fits your problem. Most commonly a topical antibacterial/antifungal agent (eardrop) and

occasionally oral antibiotic pills will be prescribed which should be used precisely according to your doctor's instructions and only on the occasion it is prescribed. Ignoring this can lead to acute OT and/or a much more resistant secondary infection.(8),(61)

Whether or not you've experienced the effects of OE in the past, by this point you should have the desire to avoid it in the future.

VI. Preventative Measures

It is clear that if you already have OT, there is no treatment available that would fix the problem instantly. Whether you are in the middle of a freediving course, you have a pool training scheduled tomorrow or your bags are packed for that liveaboard holiday – the mildest OE can ruin your plans. And what can provide a better solution to a problem than treatment? To avoid having any problems in the first place.

The way to prevent an OE is to either eliminate contributing factors where possible or to lessen their effects for example:

- Avoid getting your ears wet – this option is not for a freediver.
- Rinse your ears after every dive session with clean water so there's no irritating chemicals, dirt, salt, etc. left in the canal;
- After getting out of the water, dry your ears gently. You can leave them exposed to the sun or use a hairdryer on low setting if available;
- If you are diving in cold weather, allow your ears to dry thoroughly before you put on a hat, headband, etc.;
- You can use a hooded wetsuit or divers' earplugs to reduce water movement in your ears so to prevent dissolution of cerumen;

- Train in a salt-water swimming pool if available;
- Use a fan instead of an air-conditioner, or at least clean the unit regularly;
- And what works best for me and many others:
  Coat your ears with an extra protective layer before you dive.

(27),(28),(19)

Protective coating

Using a protective coating agent that finely coats the ear canal before and after a dive session can work extremely well by creating a water resistant & repellent barrier. This reduces the likelihood of:

- Dissolution of cerumen;
- Trapped water;
- Irritants and allergens getting in contact with the skin/eardrum;
- Softening of the skin from excessive exposure to water/moist;

Added natural antifungal, antibacterial, antiviral, and anti-infection properties increase the effectiveness of the coating significantly.

For the purpose of prevention, it is important to use a blend of natural essential oils/extracts, rather than standard antibiotics. Why? You apply treatment only when the infection occurs. On the other hand, you apply prevention every time you feel there might be a risk. Natural agents such as grape seed or tea tree oil after repeated application do not have reduced effectiveness against fungi/bacteria associated with OE. In return, the susceptibility of fungi and bacteria to standard antibiotics is reduced by each use. Thus, use of them is not sustainable in the long run.(35),(36),(37)

Make your own

A very effective mix to prevent OE is Olive Oil and Tea Tree Oil (9:1)

Pure Virgin **Olive Oil** has some antibacterial, antifungal, antiviral and anti-inflammatory effects and has no toxic effects on the skin. It is an easily obtainable water repellent coating and carrier material.(38),(39),(40),(41),(42)

Tea Tree Oil has proven to be an effective anti-inflammatory and anti-septic agent

with some anti-fungal properties. This easily obtainable acting agent if diluted to less than 10% usually does not have any irritant or toxic effects on the skin. Although it is good to have a 24hrs patch test on your skin before putting it into your ears as 1% of people are more sensitive to tea tree than others. If any irritation occurs, increase the dilution rate and repeat the test.(35),(43),(44),(45)

Over-the-counter

A number of solutions with natural ingredients are available in stores and online. My recommendations based on research of ingredients, customer reviews, and my personal experience:

- Aerol Swim Tea Tree Oil Spray – (Blend of Tea Tree Oil, Olive Oil and Mineral Oils) – vast majority of reviews are 5/5 of which I can confirm a 100% success rate after about 40 dive sessions (which statistically would normally result in 30 ear infections in my case).(46),(47)
- Nutriobiotic Ear Drops – (Grapefruit seed extract, Tea Tree Oil, Alcohol and Vegetable Glycerin) – marketed as treatment for OE and received many poor reviews. Though the vast majority of reviews regarding prevention were 5/5.(48),(49),(50)

There are plenty other options available depending on your personal preferences/wallet/location/patience to do your own research. Although personally, I feel that the only shortcoming of the home made tea tree & olive oil blend is the difficulty to obtain an appropriate container/applicator.

Beware…

… of solutions you find online. Some can be useful some can be harmful. Make sure you understand the reasoning (and that there is one) behind any suggestion and see if it makes sense and that it applies specifically to you as freediver as well (as it is unlikely that our sport was considered in its aspects).

For instance, the use of preventative drops containing acetic acid and isopropyl alcohol before and after a dive can be very effective. This can be made at home using 50:50 white wine vinegar (4-6% acetic acid) and alcohol mixed together. Though using such mixture can lead to over-drying and irritation thus should not be used daily, only on occasions.(29),(30),(31)

Another example is Pro Ear Mask 2000. You can use this and similar masks for your dives – their volume extends to cover your ears keeping them dry and protected from external factors. Though these masks can be the perfect solution for scuba divers, their bulkiness breaks streamline and is not prepared to stay in position while we move fast through water. Also, the volume of the masks is

much larger than of those preferred by freedivers - hence we will need much more of our one lungful of air to equalize them on descent.(32),(33),(34)

VII. Conclusion

Many freedivers suffer from the different types of Otitis Externa on a regular basis. Although many effective treatments are available to clear up an infection quickly, by the time our ears are healed we've encountered a number of inconveniences at least. Treatment is hardly ever a sustainable solution regarding recurring problems – PREVENTION is. Prevention primarily consists of avoiding the many precipitants that have been discussed. The most conclusive preventative measure for a freediver is the application of a protective coating in the ears before every dive session. Ingredients of such coating are crucial to be natural extracts in order to be a sustainable preventative measure.