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Swimmer's ear: Prevention, Diagnosis, Treatment, and Management Strategies for Athletes

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Abstract

Otitis externa, commonly known as a swimmer's ear, is an inflammation of the external auditory canal, often caused by bacterial infection, primarily affecting individuals engaged in water activities. Acute otitis externa is the most prevalent form among swimmers, characterized by symptoms such as ear pain, itching, and discharge. This article explores the epidemiology, anatomy, pathogenesis, diagnosis, and treatment of otitis externa, highlighting the condition's prevalence in warm, humid climates and its exacerbation by water exposure.

Differential diagnosis is crucial to distinguish a swimmer's ear from other ear conditions, such as acute otitis media. Preventive measures, particularly for athletes, include the use of earplugs, drying ears after water exposure, and avoiding ear trauma. Treatment typically involves topical antibiotics, with the addition of corticosteroids to reduce inflammation and pain. Severe cases may require oral antibiotics or surgical intervention.

Complications of untreated otitis externa might lead to hearing loss and could be life-threatening. Early diagnosis and appropriate treatment are vital to avoid severe outcomes and ensure optimal recovery for athletes and other affected individuals.

Aim

The aim of this study is to gather and analyse the current state of knowledge about the pathogenesis, symptoms, diagnosis and the treatment of swimmer's ear.

Methods

The study contains data available in freely accessible databases like PubMed, the National Library of Medicine, Google Scholar. While searching the keywords such as swimmer's ear, otitis externa, swimming hygiene, ear infections were used. Articles were selected based on their title, abstract and were written in English.

Keywords: swimmer's ear, otitis externa, swimming hygiene, ear infections

Introduction

Otitis externa is an inflammation of the external auditory canal, which can arise from infectious or non-infectious causes. Occasionally it may extend to involve outer ear structures like the pinna or tragus and proximally tympanic membrane.[1] This condition is generally classified as acute, which lasts less than six weeks, or chronic, which persists for more than three months. Acute diffuse otitis externa is the most common ear problem among swimmers. [2] It is usually caused by a bacterial infection. Chronic otitis externa can be associated with allergies, chronic dermatologic issues, or as a consequence of ineffectively treated acute cases.[3] Rarely, the infection can progress to affect surrounding soft tissues and bone leading to destruction of the temporal bone. This severe form is known as necrotizing otitis externa and is life threatening. It predominantly affects older individuals with diabetes mellitus and immunocompromised patients. [1,4]

Epidemiology

Otitis externa is a common condition that is frequently encountered across various age demographics, but it is notably rare in children under the age of 2.[5] Around 10% of the population will experience otitis externa at some point in their lives, with the vast majority of cases being acute, comprising about 95%. Gender does not appear to influence susceptibility to this condition. Moreover, occurrences are most common during the summer months and in regions characterized by warmer climates, heightened humidity, or increased exposure to water, such as swimming. [5,6]

Anatomy of the External Ear:

The external ear consists of three main parts: the auricle (or pinna), the external auditory canal (or external auditory meatus), and the tympanic membrane (or eardrum). The auricle (pinna) is the visible part of the ear outside the head, made of cartilage covered by skin. Its complex shape helps capture sound waves and direct them into the ear canal. Key components include the helix (outer rim), antihelix (inner ridge parallel to the helix), tragus (small, pointed eminence in front of the ear canal opening), antitragus (small eminence opposite the tragus), lobule (fleshy lower part without cartilage), and concha (hollow next to the ear canal that helps funnel sound). The external auditory canal (external auditory meatus) is a 2.5 cm long tube that runs from the outer ear to the tympanic membrane, featuring an S-shaped curve. It is composed of two parts: the outer part (cartilaginous), which is the outer third supported by cartilage and contains hair follicles, sebaceous glands, and ceruminous glands that produce earwax (cerumen), and the inner part (bony), which is the inner two-thirds surrounded by the temporal bone of the skull and lacks hair and glands. The tympanic membrane is a thin, cone-shaped membrane separating the external ear from the middle ear, measuring about 1 cm in diameter with a slightly concave shape. It has three layers: an outer layer continuous with the skin of the external auditory canal, a middle layer of fibrous connective tissue providing strength and structure, and an inner layer lined with a mucous membrane continuous with the middle ear lining. [2,7-9]

Pathogenesis

The external auditory canal, which is approximately 25 mm long, consists of a cartilaginous part and a bony part. The cartilaginous section, comprising lateral one-third of the canal, is covered with a skin with well-developed dermis and subcutaneous layer, producing numerous hair follicles and cerumen. It has several useful functions in the ear canal. To start with, it provides a waxy barrier that protects the epithelium from damage due to excessive moisture. Secondly, cerumen creates an acidic environment that inhibits the growth of bacteria and fungi. The bony section, comprising inner two-third of the canal, is lined with thin skin, firmly attached to the periosteum, and lacks the subcutaneous layer.

Lacking cerumen, damaging the epithelium, and accumulation of the moisture disturbs the normal acidic pH in the canal. That leads to subsequent bacterial and fungal growth causing an inflammatory reaction resulting in redness, swelling, and significant pain in the ear canal. The swelling may prompt additional symptoms like itching, discharge, and temporary hearing impairment because of blockage of the canal. The cause of otitis externa is most commonly bacterial infection (>98%), but it can also be fungal. The most common pathogens are *Pseudomonas aeruginosa* and *Staphylococcus* species. Rare fungal infections are usually caused by Fungal *Candida* or *Aspergillus*. [2,3,11-15]

Risk factors

Various factors can predispose patients to the development of otitis externa. (Table 1). A significant and the most common risk factor is increased water exposure, especially from swimming but also other water activities. Most studies, though not all, have identified a link between water quality (specifically bacterial load) and the likelihood of developing acute otitis externa. The bacteria responsible for this condition are commonly found in swimming pools and hot tubs. Even those facilities that meet water quality standards may still include otitis externa pathogens. [5] The study conducted by Steuer et al. showed that people with type A blood may have a genetic predisposition that makes them more susceptible to acute otitis externa [16] Another trial run by Hoadley et al. demonstrated that swimmers were 5 times more likely to develop otitis externa and they experienced pain of the ear 2.4 times more frequently than non-swimmers. What's more, among swimmers, the risk of *P.aeruginosa* etiology of otitis externa was heightened, and the infections were reported to be generally more severe. [17]

Additionally, organisms responsible for otitis externa can be present in the healthy external auditory canal, making it a potential source of otitis externa. [5] Other contributing factors include increased moisture in the ear canal. The condition tends to occur more frequently in areas with warmer weather and higher humidity levels. Additionally, loss of protective cerumen through excessive cleaning may result in easier entry of the pathogens. [11] Furthermore, inserting objects like cotton swabs, earplugs, and hearing devices plays a role and may cause disruption of the epithelial cover in the ear canal. Other risk factors are dermatologic disorders of the auditory canal such as eczema, psoriasis, seborrhea, atopic dermatitis, and anatomic abnormalities for example narrow canal. [18]

Table 1. [1]

Anatomic abnormalities	<ul style="list-style-type: none">- Ear canal stenosis- Exostoses
Canal obstruction	<ul style="list-style-type: none">- Foreign object- Sebaceous cyst- Obstruction by cerumen
Epithelial integrity	<ul style="list-style-type: none">- Cotton swabs- Earplugs- Hearing devices
Dermatologic disorders	<ul style="list-style-type: none">- Eczema- Seborrhea- Atopic dermatitis- Psoriasis- Other inflammatory dermatoses
Increased moisture in the ear canal	<ul style="list-style-type: none">- Humidity- Sweating- Swimming- Prolonged water exposure
Other	<ul style="list-style-type: none">- Type A blood- Stress- Radiotherapy or chemotherapy

Diagnosis

Diagnosis of otitis externa involves taking a medical history and performing a physical examination of the ear. Swimmer's ear typically occurs in patients who have been exposed to water, and it can also be associated with previous trauma to the ear canal. Symptoms occur typically within 48 hours, in the past 3 weeks. Patients often present with signs of inflammation in the ear canal, including severe ear pain (otalgia), itching, or a sensation of fullness. These symptoms may occur with or without accompanying hearing loss or jaw pain. An otoscope is used to visualize the ear canal and tympanic membrane, revealing potential redness, swelling, and discharge. Manipulation of the pinna or tragus may elicit significant pain, which is a key physical finding in diffuse otitis externa. If discharge is observed during examination, ear swabs are collected for bacterial culture and sensitivity testing to guide targeted antibiotic therapy. Additionally, examination may reveal regional lymphadenitis,

including postauricular, subauricular, and occasionally, periauricular parotid areas and cellulitis affecting the pinna and adjacent skin. [5,18]

Differential diagnosis

Differential diagnosis of swimmer's ear is crucial for ensuring appropriate treatment and management. Swimmer's ear shares symptoms, like ear pain, itching, and discharge, with several other conditions, including acute otitis media, chronic suppurative otitis media, and contact dermatitis. Distinguishing swimmer's ear from other conditions is essential because treatment approaches differ significantly; for instance, bacterial otitis media may require systemic antibiotics, while swimmer's ear often responds to topical treatments. Accurate diagnosis prevents unnecessary treatments and helps target the underlying cause of symptoms, improving patient outcomes and reducing the risk of complications.

Acute otitis media, for example, typically presents with middle ear effusion and lacks the tragal or pinna tenderness characteristic of otitis externa. Chronic suppurative otitis media, on the other hand, is marked by persistent ear discharge through a perforated tympanic membrane, contrasting with the diffuse canal inflammation seen in otitis externa.

Contact dermatitis can mimic otitis externa but is usually linked to exposure to allergens, like earrings or ear drops, and primarily causes itching rather than pain. Fungal infections, such as otomycosis, present with thick discharge and visible fungal elements on otoscopy, unlike the bacterial nature of most otitis externa cases. Acute diffuse otitis externa needs to be distinguished from other variations of otitis externa, including herpes zoster oticus, eczematoid otitis, seborrheic otitis, and malignant otitis externa. Herpes zoster oticus, a herpes infection involving the ear canal and auricle, presents with vesicles and serous discharge, in contrast to the purulent discharge seen in bacterial otitis externa. Symptoms of eczematoid otitis externa are often chronic, with itching as the predominant symptom, along with dry, scaly skin. eczema is frequently associated with a history of atopy, such as asthma or other forms of dermatitis, and may involve outbreaks in other body locations. In comparison, eczema presents with dry, flaky, and thickened skin in the ear canal without significant edema. Seborrheic otitis externa is characterized by chronic itching and is linked to seborrheic dermatitis, with presence of yellowish, greasy scaling of the ear canal and other areas, particularly the scalp. In immunocompromised patients, malignant otitis externa presents with severe ear pain, high fever, granulation tissue or necrotic tissue in the ear canal, possible cranial nerve involvement and significant findings on computed tomography. [1,3,19]

Table 2. [1]

Condition	Distinguishing characteristics
Acute otitis media	Presence of middle ear effusion, no tragal/pinnal tenderness
Chronic otitis externa	Itching is often predominant symptom, erythematous canal, lasts more than three months

Chronic suppurative otitis media	Chronic otorrhea, nonintact tympanic membrane
Contact dermatitis	Allergic reaction to materials (e.g., metals, soaps, plastics) in contact with the skin/epithelium; itching is predominant symptom
Eczematoid otitis externa	itching is predominant symptom; often chronic; history of atopy, outbreaks in other locations
Seborrhea	Itching and rash on hairline, face, scalp
Malignant otitis externa	High fever, granulation tissue or necrotic tissue in ear canal, may have cranial nerve involvement; patient with diabetes mellitus or immunocompromised, elevated erythrocyte sedimentation rate, findings on computed tomography
Myringitis	Tympanic membrane inflammation, may have vesicles; pain is often severe, no canal edema
Otomycosis	Itching is predominant symptom, thick material in canal, less edema; may see fungal elements on otoscopy
Ramsay Hunt syndrome (herpes zoster oticus)	Herpetic ulcers in canal; may have facial numbness/paralysis, severe pain, loss of taste
Referred pain	Normal ear examination
Furunculosis	Focal infection, may be pustule or nodule, often in distal canal
Sensitization to otics	Severe itching, maculopapular or erythematous rash in conchal bowl and canal; may have streak on pinna where preparation contacted skin; vesicles may be present

Prevention

Patients with recurrent Otitis Externa are recommended to take steps to prevent future episodes by limiting predisposing factors. It is especially useful for professional athletes. It includes: [1,11]

- using well-fitting earplugs or a swim cap while swimming to keep the ear canal dry and avoid excess moisture
- gently tilting the head and pulling to empty remaining water after water exposure, using a hair-dryer on the lowest heat setting might be helpful
- avoiding ear trauma by inserting objects, such as cotton swabs to maintain a healthy skin barrier
- applying over-the-counter acidifying drops (2%) after swimming to dry the ear canal and prevent infections
- proper treatment of any existing dermatological conditions

However, more randomized trials are needed to assess the effectiveness of these measures.

Treatment

The majority of individuals with external otitis can receive treatment at home. If the infection is severe, symptoms of swimmer's ear are present or the eardrum is ruptured, seeking medical advice is crucial. Management encompasses several strategies, including frequent cleansing of the ear canal, pain control, administering oral or topical medications, acidification of the ear canal, and addressing predisposing factors. [20]

The primary outcome of the clinical practice guideline developed by Rosenfeld et. al. focuses on achieving clinical resolution of AOE, which it entails resolving all signs and symptoms, such as pain, fever, and otorrhea. Other goals include reducing ineffective treatments, eliminating pathogens, minimizing recurrence and complications, enabling the uninterrupted use of necessary hearing aids, optimizing health-related quality of life and enhancing patient satisfaction. [2,5]

The primary treatment involves using antibiotic ear drops for approximately a week; oral antibiotics are generally not necessary. Antibiotics used in topical therapy include: aminoglycosides such as gentamicin and neomycin, polypeptides like gramicidin and polymyxin B, and fluoroquinolones such as ciprofloxacin. [21]

These drops may also contain a steroid to reduce swelling and pain. Effective topical treatments include acetic acid, boric acid, aluminum acetate, silver nitrate, and the endogenous antiseptic N-chlorotaurine. Ear drops containing corticosteroids are more effective than those with acetic acid, which is comparable to antibiotic/steroid treatment at week 1, but becomes less effective with extended use. [22,23]

Effective pain management is crucial in the treatment of AOE. The clinician needs to evaluate patients for pain and suggest appropriate analgesic treatment according to the pain's severity. Mild to moderate pain typically improves with acetaminophen or nonsteroidal anti-inflammatory drugs (NSAIDs), either alone or in combination with an opioid, such as oxycodone or hydrocodone; or ibuprofen combined with oxycodone.

In cases of severe inflammation and tenderness of the canal, patients may require acute pain relief and, on occasion, sedation during procedures to ensure thorough aural toilet. [24]

It is crucial to complete the entire course of treatment to prevent repeat infections. In cases of significant swelling, an ear, nose, and throat (ENT) specialist might need to insert an ear wick to keep the ear canal open, allowing the antibiotic drops to reach the infection. The ENT specialist may also need to clean the ear. Cleansing can be accomplished through irrigation, gentle suction, and the careful application of cotton swabs, all under direct visualization. Clearing away discharge and debris can facilitate the application of topical medications. The ear canal can be dried using 70% alcohol. To prevent infections, ears should be kept dry, objects should not be inserted into the ear, and ear devices should be cleaned regularly.

Symptoms should improve within a few days of starting treatment, with most patients fully healing within 7 to 10 days. If symptoms do not improve, it may indicate a more serious condition, necessitating a consultation with an ENT specialist. Untreated, there is a risk of the infection spreading to nearby bones or skin. Prolonged infections can lead to decreased hearing and scarring. [25,26]

Complications

In acute otitis externa (AOE), the infection can extend from the ear canal to nearby areas, causing conditions like cellulitis of the ear or face, inflammation of the tissue around the cartilage (perichondritis), or inflammation of the cartilage (chondritis). [11] Other complications includes:

Chronic otitis externa

Acute otitis externa may develop into chronic otitis externa, which is an inflammatory condition of the auditory canal caused rather by allergic or autoimmune etiology, but also chronic bacterial or fungal infection. It affects 3-5% of the population. [27] It's diagnosed in patients with symptoms lasting at least 3 months. Symptoms may include persistent itching, ear pain, redness and swelling, tenderness, a feeling of fullness or pressure. During diagnostics, chronic skin conditions should be considered, especially if a rash is presented elsewhere. Skin-patch testing might be helpful in identifying allergens. Treatment of chronic otitis externa (COE) focuses on identifying the underlying cause and providing appropriate management. It is aimed at eliminating any potential factors affecting the ear canal skin, reducing inflammation through medical therapies, and investigating the underlying cause, whether it stems from external factors (such as contact dermatitis) or internal factors (autoimmune or atopic). It may result in narrowing of the ear canal and cause hearing loss. [23]

Malignant (necrotizing) otitis externa

Malignant otitis externa is a very severe, potentially life-threatening complication of acute otitis externa. It involves infection of the external ear and nearby structures, including the

periosteum and temporal bone of the skull base. [3,11] The disease mostly affects immunocompromised patients, over 65 years old, especially with diabetes (90-100% of the patients with malignant otitis have diabetes mellitus), hematological conditions such as leukaemia, granulocytopenia or arteriosclerosis. [28,29,30] The infection is typically caused by *Pseudomonas aeruginosa*, but other bacteria, including MRSA and fungi, can be involved. Due to the high mortality rate, early diagnosis is crucial.

Clinicians should consider the diagnosis in patients with diabetes or compromised immune system who present with otitis externa and fever unresponsive to initial treatment. Additional complications may involve meningitis, dural sinus thrombosis, cranial abscesses, and cranial nerve palsies. Facial nerve paralysis can manifest early in the course of the infection. Treatment typically starts with empiric intravenous antibiotics effective against *Pseudomonas aeruginosa*. For severe or resistant cases, surgical debridement may be required. [31,32]

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