Introduction

Otitis externa can be defined as inflammation or infection of the external ear. It includes all inflammatory conditions of the auricle, the external ear canal, and the outer surface of the tympanic membrane. It is a very common childhood disease which is also known as “swimmers ear” and “tropical ear.” It can be either an acute or a chronic condition which has multiple etiologies including infectious, traumatic, and allergic. Otitis externa encompasses a spectrum of disease severity ranging from minor infection to life threatening disease.

History of Otitis Externa

Otitis externa has been treated a number of different ways over the last three thousand years. Some common treatments around 1500 B.C. included a combination of red lead (lead tetroxide, a red pigment used in ancient Rome) with resin, olive oil, frankincense, and goose grease. Ear candling, a technique in which a hollow candle is inserted into the ear, began around 1000 A.D. In the early 20th Century, ear potions containing various ingredients such as turpentine, camphor, sassafras, and menthol were popular. Alcohols and other topical astringents were used in the mid-20th Century to treat otitis externa before topical antibiotics were available.

Mayer is credited with first formally describing otitis externa in the literature in 1844 when it was believed to be primarily of fungal origin. Its etiology was re-examined during WWII by the Army because a high percentage of soldiers stationed in the South Pacific were diagnosed with otitis externa. In fact, up to 70% of the caseload for military ENT’s was dealing with OE. During this time, it was found to be largely an infection of bacterial causes.

Review of Anatomy

The outer ear contains multiple structures. The pinna is visible on gross inspection and is supported by an elastic cartilage framework. The external auditory canal is divided into two parts. First, the outer third is the cartilaginous portion which contains sebaceous and apocrine glands. Cerumen, a combination of gland secretions and desquamated cells, is produced in this segment of the canal. The inner two thirds is the inner osseous portion. Containing no adnexal structures, this section is lined by squamous epithelium. Normal ear flora includes S. epidermidis, Corynacterium, and alpha hemolytic streptococcus species.
**Cerumen**

Some controversy exists over cerumen, but most experts believe that cerumen aids in defense against organisms that cause otitis externa. Ear wax contains the enzyme lysozye, which possesses antibacterial properties. In addition, it creates an acidic environment in the external auditory canal (pH 6-6.5). Staph aureus and pseudomonas (the two most common otitis externa pathogens) grow best at pH 8-10.

**Pathophysiology**

Infection happens when there is a breakdown in the skin/cerumen protective barrier of the external ear canal. If left untreated, the infection progresses through three different phases: pre-inflammatory, inflammatory, and chronic. During the pre-inflammatory stage an insult occurs such as moisture getting trapped or trauma to the external ear. The skin becomes edematous, which blocks the glands. The next stage is the inflammatory stage, which can be divided into three phases. During the mild phase the canal begins producing clear secretions in addition to edema and erythema. If the infection progresses into the moderate phase the secretions become sero-purulent and the pain and edema worsen. The severe phase is characterized by severe pain. Often the ear canal lumen becomes obstructed with purulent drainage and debris in the canal. This phase is associated with pre-auricular edema and adenopathy. If the infection spreads to the tissue surrounding the EAC it is known as necrotizing otitis externa. Finally, the chronic stage is defined as an episode of otitis externa lasting for at least four weeks or a minimum of four episodes in one year.

**Microbiology of Otitis Externa**

Rates of infection due to each microbe vary depending on the source but the two most common pathogens are Pseudomonas and Staph aureus. One study found in the population sampled that 53% of cases of otitis externa were caused by gram negative organisms (Roland et al 2002). Pseudomonas was by far the most common gram negative bacteria isolated in this group. 46% of microbe isolates were gram positive bacteria including Staph Aureus and other staph species. Only 1.7% of external ear infections were due to yeast/fungal causes. There are also viral causes of external ear canal inflammation including herpes virus and varicella-zoster virus.

**Age/Seasonal Distribution**

Otitis externa affects patients of all age groups. In particular, however, there is a peak incidence between the ages of 7 and 12 years. There is also a decline after the age of 50. Children under 12 have a lower likelihood of otitis externa due to Staph Aureus (4%) than children over 12-18 (8%) (Rolland et. al). Rates of pseudomonas, however, are the same regardless of age. Over 80% of cases occur during the summer months when it is warmer and more humid.

**Clinical Presentation**

Children most commonly present with ear pain. The pain can be quite severe because the skin of the ear canal is closely adherent to the underlying perichondrium/periostium. Any manipulation of the pinna or tragus exacerbates the symptom. Patients can also complain of itchy ears, which is associated with fungal otitis externa. Often, itchy ears is precedes the ear pain. A draining ear is sometimes the chief complaint which may or may not be accompanied by hearing loss and a feeling of aural fullness.
Complications/Sequelae

Untreated or severe otitis externa can progress to a number of complications. The infectious process can produce stenosis of the ear canal. The infection can also spread and cause cellulitis or chondritis in the surrounding area. If the infection continues to expand, it can involve the parotid gland. When the infection spreads to the structures surrounding the external ear, it is known as malignant or necrotizing otitis externa. Fortunately, this spectrum of the disease is rarely seen in children and is almost never fatal for them (adult mortality rate for malignant otitis externa approaches 20%). Children who suffer from malignant otitis externa are typically immune-compromised (e.g. leukemia, drug-induced leucopenia, immunoglobulin deficiency, or diabetes).

Differential Diagnosis

When suspecting otitis externa, there are a number of other diseases one must consider. The differential for otalgia is very broad because pain from many other structures is frequently referred to the ear. Any process involving the teeth, tonsils, TMJ, larynx, neck, and sphenoid sinus can be perceived as otalgia (cranial nerves 5, 6, 9, and 10 all provide sensory innervation to the middle and external ear). In addition to these, there are a few other specific conditions that are local in the ear to consider. Furunculosis occurs in the hair bearing (lateral third) portion of the external ear canal. It is differentiated from otitis externa because the swelling associated with it tends to be localized to a single quadrant. Swelling in the ear canal seen in otitis externa is usually concentric and involves the entire length of the canal.

Otitis media must also be considered. The examiner must visualize the tympanic membrane to differentiate it from otitis externa. In addition, whether or not the TM is intact may affect treatment options. Mastoiditis can be diagnosed if the post-auricular fold is obliterated (it is preserved in otitis externa). Patients also have pain to palpation over the mastoid process in mastoiditis rather than pain with manipulation of the pinna.

Relevant History

**Pediatric Acute Infectious Otitis Externa**

Assess the pain level. Otitis externa is painful, but very severe pain is more characteristic of a furuncle. Children who develop otitis externa frequently have a history of recent swimming. Also ask about any recent ear trauma (q tip use, ear syringing, hearing aide use, ear plugs, or foreign body in the ear canal). Inquire about immune status. Immunocompromised patients are at risk of severe/necrotizing infection. Other dermatologic conditions such as contact dermatitis, eczema, and psoriasis predispose to otitis externa. Previous history of ear disease or ear surgery is also significant.

**Physical Exam**

On inspection, observe if there is ear drainage. Thick and clumpy secretions are typical of otitis externa. In particular, green and foul smelling discharge is classic of pseudomonas infection. Mucoid drainage is more characteristic of middle ear pathology rather than otitis externa. Also observe if there is surrounding cellulitis. If there is, it is important to mark the edge to monitor response to treatment. A protruding pinna can also be visualized by inspection alone. This finding is associated with a post-auricular abscess (complication of mastoiditis). Observe any facial paralysis, which is a sign of severe infection. Palpate the mastoid for tenderness (a sign of mastoiditis) and feel for any lymph nodes in the peri and pre-auricular areas (markers of severe infection).
Perform otoscopy and look for several key findings. Edema/erythema of the canal, narrowing of the canal, debris in the canal, and purulent secretions are all typical findings in otitis externa. Determine if the TM is intact or perforated. In the case of aspergillus infection, black fungal hyphae can be seen on the TM. Otoscopic exam may reveal vesicles in the canal, a condition known as herpes zoster-oticus. The tympanic membrane itself can also be inflamed. This condition, myringitis, can be due to primary or secondary causes.

**Diagnostic Testing**

There is no consensus in the literature concerning culturing. Many clinicians culture initially if physical exam findings lead them to suspect a fungal cause. In addition, culture of ear secretions is warranted after the first treatment failure to identify the organism and prescribe effective anti-microbial therapy. Imaging may be obtained based on clinical suspicion. In the event of suspected malignant otitis externa, CT scan or isotope bone scan can help make the diagnosis.

**Treatment Goals**

When treating otitis externa, the physician should take into account several goals. First, prescribe antimicrobial therapy that eradicates the 2 most common bacterial causes: Pseudomonas and Staph aureus. Second, achieve aural toilet. It is imperative to remove as much debris as possible from the ear canal so topical medications can be effective. Third, achieve pain control. Otitis externa is a painful condition. Fourth, have the patient keep his/her ears dry. Continued exposure to moisture can slow recovery. Fifth, instruct the patient in the proper use of topical ear drops. For a child, the parent/caretaker should place the drops. The child should lie on his/her side with the affected ear up. The drops should be placed in the canal and the tragus should be pumped several times so the medication can get deeper into the canal. The child should remain in the same position for 5 minutes. Finally, use an ear wick when appropriate. Ear wicks are typically warranted if there is significant canal narrowing (50%) which indicates significant infection.

**Non-Antibiotic Topical Treatments**

Boric acid, acetic acid (available commercially in combination with a steroid: Vosol HC) and alcohols are commonly used to treat otitis externa. Boric acid is used in solution at a concentration of 2.75%. Commercial preparations of acetic acid use a concentration of 2%. Alcohol is effective at concentrations between 90-95%. Each agent works by creating an acidic or toxic environment that is not conducive for bacterial/fungal growth. They are very inexpensive and work against both bacteria and fungi. They have a number of downsides, however, which limit their use. They only work well when used early in the disease process. In addition, they can be painful to use. They also require multiple treatments per day for a long treatment period (up to 3 weeks). Finally, they can be ototoxic if they get into the middle ear cavity.

**Topical Antibiotic Treatment Options:**

**Aminoglycosides**

Aminoglycosides were used as first-line therapy during the 1970’s through the late 1990’s for treatment of otitis externa. Neomycin is often combined with a second antibiotic (polymixin) and a steroid. The polymixin adds pseudomonas coverage. Polymixin/neomycin combination has an 87-97% cure rate and is relatively inexpensive. Gentamicin is also sometimes used as a topical agent.
Aminoglycosides have several drawbacks that limit their use. Hypersensitivity reactions to neomycin (up to 53% of patients) and its preserving agent thimerisol (up to 18%) occur frequently. Although ototoxicity with topical aminoglycosides is rare, it can happen with a tympanic membrane perforation. This is particularly significant because treatment for otitis externa is sometimes started without being able to adequately visualize the eardrum. Finally, aminoglycoside topical antibiotics require QID dosing.

**Topical Antibiotic Treatment Options: Quinolones**

Floroquinolones were developed in the 1980’s, but became available as otic topical preparations in the late 1990’s. Three different commercial preparations are available: ciprodex (Ciprofloxacin0.3% and dexamethasone 0.1%), CiproHC (ciprofloxacin 0.2% and 1% hydrocortisone) and Floxin Otic (Ofloxacin 0.3%). They are currently first-line therapy for otitis externa. Quinolones offer several advantages. First, they cover both gram positive and gram negative organisms and their efficacy is considered equivalent to aminoglycosides. Second, they only require BID dosing. Third, there is negligible systemic absorption which allows use in pediatric populations. Fourth, there is no known ototoxicity associated with quinolones. Fifth, Floxin Otic and Ciprodex are FDA approved to treat otitis externa with a perforated tympanic membrane. Finally, allergies to quinolones are very rare and are usually associated with oral use. The drawback of quinolones is their cost.

*Quinolones vs. Aminoglycosides and Oral Antibiotics.*

In the late 1990’s a significant percentage of primary care physicians were prescribing topical antibiotics and oral antibiotics to treat otitis externa. Rolland et. al. performed a study in 2008 in which topical quinolones were compared with topical aminoglycosides plus oral amoxicillin. This prospective randomized controlled trial showed equivalent outcomes in both groups. These findings provide evidence that topical quinolones are as effective as topical aminoglycosides and that oral antibiotics are not necessary in the treatment of routine otitis externa.

**Topical Antifungals**

There are a few commercially available anti-fungal preparations to treat fungal otitis externa. These products are well known as creams, but can also be used in a solution for the ear. Lotrimin (1% clotrimazole) and Tinactin (tolnaftate) are effective to treat fungal infections. Many treatment algorithms add anti-fungal coverage if suspected upon initial presentation and/or after the first treatment failure with a quinolone.

**Prevention of Otitis Externa**

Patients can employ several strategies for avoiding otitis externa. Ear plugs can be used to prevent moisture in the external ear. Over-the-counter ear plugs are available, but cotton balls with petroleum jelly also work well. Astringents (e.g. alcohols) are also effective as a preventative after water exposure to the ear. Drying the ear with a hair dryer held 1 ft from the ear can aid in moisture evaporation from the ear canal. Finally, avoidance of Q-tips in the ear is crucial to prevent otitis externa.

**Prevention of Otitis Externa: Q-Tips**

Nussinovitch et al conducted a study of all children diagnosed with acute otitis externa over a 3 year period at their medical institution. When compared to age-matched controls without otitis externa, they found a statistically significant difference between the use of Q-tips in the group diagnosed with otitis externa.
**Controversies/Trends**

Martin et al conducted a study examining the rates of infection due to different pathogens. They noticed a sharp increase in the number of fungal otitis externa cases in the years after the topical quinolone preparations became available. They theorize that quinolones are so effective in eradicating bacteria in the ear canal, that fungi and yeast are selected to replicate normal ear flora as a result. These studies were observational which can only show a correlation and further studies are needed to prove a causal relationship. The authors state. However, that quinolones are still an excellent choice to treat otitis externa.

**DISCUSSION: Shraddha Mukerji, MD**

Acute infectious otitis externa is very common in children. It is particularly troublesome during the summer months when majority of the kids are actively swimming. The most important infectious agents are bacterial (staph and pseudomonas), but as pedi ENT physicians, we see a lot of children with fungal otitis externa. The main reason for this is chronic use of quinolone ear drops which is the first line treatment for otitis externa in children. Chronic use of these drops alters the normal flora of the skin of the EAC and predisposes to fungal infection. The treatment consists of aural toilet and keeping the ear dry along with ear drops to fight infection and relieve pain. Fever and other systemic symptoms are absent, so I usually do not start the child on oral antibiotics for OE alone.
Bibliography

- Wall GM, Stroman DW, Roland PS, Dohar J. Ciprofloxacin 0.3%/Dexamethasone 0.1% Sterile Otic Suspension for the Topical Treatment of Ear Infections. The Pediatric Infectious Disease Journal . 2009;28:141-144.