The Microbial Aetiology of Otitis Externa: A Review

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The aetiology of otitis externa (OE) is reviewed. This inflammation of the outer ear canal is common especially in warmer, humid climates such as parts of Saudi Arabia. The outer ear canal is protected against infection by normal bacterial flora, cerumen (earwax) and the cornified layer of epithelium. Factors which remove these protective elements increase susceptibility to OE. The major factor in predisposing to OE is an aquatic environment. It is reported in whirlpool users, swimmers and underwater divers. Infection is an usual component of the inflammation in OE. Pseudomonas aeruginosa is most frequently found in OE with an aquatic-related aetiology. Moulds, especially Aspergillus species, are common in the tropics and after antibiotic usage. Staphylococcus aureus was frequently isolated in some studies. 'Malignant' or 'invasive' OE is a serious form in debilitated patients and P. aeruginosa is almost always involved. An intact immune apparatus is important in the host defence against OE. Some of the problems peculiar to the hyperbaric environment in the aetiology of OE are discussed. Suggestions for further research areas are given: the climate and marine environment of Saudi Arabia provide an ideal opportunity for such studies.

Otitis externa (external otitis) (OE) is a diffuse inflammation of the external auditory canal. It has many popular names including 'jungle rot', Singapore ear and Dhoby ear,
1 confirming that it is a common disorder in hot and humid conditions such as parts of Saudi Arabia. The central role of moisture will be discussed further in later sections in terms of change in normal flora, isolation of microbial pathogens and outbreaks of OE. Clinically characterized by discomfort, ranging from itching to intense pain in the ear and sometimes swelling and discharge,2 OE is also common in mammals and the same microbes as in human infection are often implicated.

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Normal Microbial Flora

The normal microbial flora of the external auditory canal consists predominantly of Gram-positive bacteria, including coagulase-negative staphylococci, mainly Staphylococcus epidermidis and diphtheroids. In a Norwegian study, 4.7% of males were carriers of Staphylococcus aureus but no females. Males had generally more normal flora than females and more fungal isolates. Gram-negative bacilli are unusual in normal ear flora, although in one study, 11% of children were colonized by Pseudomonas aeruginosa. A study in normal adults showed a mainly Gram-positive flora, found also in diabetics. Water contact (diving and swimming) leads to a shift from Gram-positive normal flora to a predominantly Gram-negative flora. Brook demonstrated that diving hoods increased the amount of retrievable normal flora. It is important to distinguish between colonization by Gram-negative organisms and actual infection. Further studies are required to determine the relationship and differences between Gram-negative colonization and infection. Why do some individuals develop signs of infection and others not? Are there differences between colonizing and infecting Gram-negative rods? Is the host response different? Such questions are at present largely unanswered.

General Pathogenesis of Otitis Externa

Factors which destroy or compromise the impermeable barrier within the external auditory canal will facilitate microbial infection. Experiments in cats have supported this view. The barrier can be breached by trauma such as abrasion caused by scratching or even by an insect. Underlying skin conditions such as seborrhoea or eczema, psoriasis and experimental dermatitis in the canal can also have a similar effect. Use of swabs in the external ear canal reverses the normal outward migration of cerumen and debris and encourages the development of OE. Probably the main predisposing cause of OE is, however, moisture and it is common in humid or wet environments especially in warm climates, thus it is common in the tropics and aquatic environments such as after whirlpool use, swimming, and diving (see below). Oclusion of the external ear is also a predisposing factor for OE for example the wearing of headsets. There is some racial variance in the length and width of the canal perhaps resulting in a lesser degree of moisture accumulation in Negros who are reported to have a low incidence of OE. It has been shown that superhydration of skin can result in an infection with Pseudomonas. A rise in the pH of the external auditory canal may also be associated with infection, either as a pre-disposing factor or during the course of the infection.

Cerumen

Cerumen (earwax) contains a variety of chemical substances. Normal production can be disrupted by moisture and reduction of cerumen is an important feature of OE prior to and during the infection. Cerumen occurs in two forms—dry and wet—showing racial variation and correlated with relative humidity in the area. It would be of interest to compare the incidence of OE in groups with dry and wet cerumen types in a cosmopolitan area such as Saudi Arabia. Cerumen has an antibacterial effect in vitro which may be of importance in suppressing potentially pathogenic bacteria, although no difference in the content of antibacterial polynsaturated fatty acids could be found in patients with and without recurrent OE.

Aquatic Environment

Otitis externa is reported in swimmers in contaminated swimming pools. This has been related to inadequate disinfection. A similar association has been found in freshwater lakes in Canada. Other aquatic causes of OE are whirlpools, and bath sponges. Divers are particularly disposed to OE. These include sports divers but especially professional saturation divers who live under high pressures in enclosed chambers for up to several weeks. Temperatures in the chambers are high in order to reduce body heat loss in the helium-containing atmosphere— as is humidity and there is frequent water contact. In the peculiar and enclosed environment of the diving chamber, infection may spread from one diver to another and this can have immense economic consequences for the work operation concerned. Hyperbaric oxygen which can be a feature of the saturation diver’s environment can change the characteristics of P. aeruginosa and may thus influence the pathogenesis of OE in these cases. ‘Coral ear’ is a form of OE that follows prolonged contact with sea water around coral formations: the extensive coral reef off Saudi Arabia’s Red Sea coastline and the large number of sports divers there would provide an ideal material for a closer study of this condition which has unclear aetiology.
Table 1

<table>
<thead>
<tr>
<th>Area</th>
<th>Microbial aetiology, % of total cases</th>
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<tbody>
<tr>
<td></td>
<td><em>Pseudomonas aeruginosa</em></td>
</tr>
<tr>
<td>Scandinavia</td>
<td>22</td>
</tr>
<tr>
<td>East Africa</td>
<td>38</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>35</td>
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<tr>
<td>USA</td>
<td>61</td>
</tr>
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NA = Results not available.

**Microbes Isolated in Otitis Externa**

Several studies have addressed the microbial aetiology from a variety of geographical areas (Table 1). A study from Norway found that *Staphylococcus aureus* (34% of cases) was the commonest pathogenic microbe isolated, followed by *Pseudomonas aeruginosa* (22%) and *Streptococcus pyogenes* (9%). In contrast, one study reported *Streptococcus pyogenes* as being an unusual cause of OE. *Staphylococcus aureus* and *Pseudomonas aeruginosa* are seldom isolated together, possibly due to the production of mutually inhibitory substances by these organisms. The frequency of mixed flora infections suggests that the microbial process in OE is dynamic and that findings may be dependent upon the time of sampling. In the Norwegian study, 9% of samples contained fungi. Studies from warmer climates including Saudi Arabia, Burma, Tanzania and Pakistan show a far higher incidence of fungal infection, notably *Aspergillus* sp. The climate and widespread use of antibacterial ear drops in some countries may deplete the canal of normal flora and facilitate fungal colonization. Otomycosis is predominantly a disease of males and fungal carrier rates in normal ear canals are higher in males. *Malassezia furfur* does not appear to be isolated frequently from cases of OE but is found in the normal ear canal. Unusual causes of OE include *Pasteurella multocida* in a patient whose pet cat used to lick his face and a wide variety of other organisms have been implicated. Otitis externa associated with water contact seems usually to involve Gram-negative rods, particularly *P. aeruginosa* and has been reported in swimmers, divers and whirlpool users. *Pseudomonas aeruginosa* in particular appears to be highly infectious; dominance of particular serotypes, especially O-11 having been reported. In the author's experience, however, a wide variety of *P. aeruginosa* serotypes can be found in OE varying from geographical area to area as was presented recently in a comparative study from Saudi Arabia, Norway and Sri Lanka, although serotype O-11 was dominant in the collections from both Saudi Arabia and Sri Lanka; these data will be published more comprehensively later. More studies should be performed on the characteristics of *P. aeruginosa* isolated from cases of OE in order to see if they differ from more common environmental isolates. There is considerable information available on the pathogenesis of *P. aeruginosa* infection although little relates to OE specifically and more research is needed.

**Malignant Otitis Externa**

Malignant (or invasive) OE denotes a particularly severe form of OE with subcutaneous involvement and complications including mastoiditis, facial palsy and a significant mortality. It occurs primarily in the elderly, diabetics and the immunocompromised including AIDS patients. *Pseudomonas aeruginosa* is the most commonly reported cause, although *S. aureus* and *Aspergillus fumigatus* are occasional causes. Water contact is an usual predisposing factor for malignant OE caused by *P. aeruginosa*. The majority of patients with malignant OE in one study had recently received ear irrigation, raising the worrying possibility of partial iatrogenic aetiology.

**Immunology of Otitis Externa**

An intact immune apparatus is important for host defence against serious OE. Defective neutrophil leukocyte migration ability has been demonstrated in a patient with malignant OE. Cellular immune deficiency has also been reported in malignant OE but the humoral immune response may also be protective as *P. aeruginosa* infection in chronic ear disease was reduced by a specific vaccination. A pressurized environment can lead to major changes in cellular structure and behaviour. Specifically, pressure can denature gammaglobulin and hyperbaric oxygenation can be immunosuppressive. Such mechanisms could
perhaps partially explain the vulnerability of divers to OE and more work is needed in this area.

Conclusions

Otitis externa is a common disease which can range in severity from troublesome to life-threatening. The aetiology of OE is multifactorial and complex. Microbial infection is the most important process often resulting from the reduction or change in normal outer ear canal flora. Changes in the normal flora are induced by an aquatic environment and use of antibacterial ear drops. Ear wax is antibacterial but has an uncertain importance in the prevention of OE. The immune apparatus appears to have a protective role as the severity of the disease is greatest in the immunologically compromised. More work is especially needed on the causes of OE in divers and swimmers as these groups are so often afflicted. There is scope for further study in Saudi Arabia because of the high incidence of OE and the large number of people who pursue aquatic activities.

References


