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Study of Bacterial Flora in Children's with Hearing Aid Earmoulds in Ahvaz, Iran

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Abstract: The aim of this study was to determine the presence and nature of bacterial flora on hearing aids earmoulds in a children's population. The study population consisted of 119 children referred to Imam Ali and Rudaky Schools in Ahvaz, Iran. Three samples were taken from surface of hearing aids earmoulds; canal in hearing aid wearers and ear without hearing aids earmoulds. The samples were cultured directly onto blood agar and MacConkey agar plates. According to preliminary examination, necessary standard biochemical tests were performed on grown bacteria and the organisms were identified as per standard identification criteria. Totally, 66 samples (61.1%) from hearing aids earmoulds and 124 samples (52.1%) from both ear canal without hearing aids earmoulds were culture positive, which 73(58.9%) and 51(41.1%) were from right and left ears, respectively. The majority of isolated bacteria from earmoulds were Coagulase-Negative Staphylococci (CNS) 40(60.6%) and Polybacterial flora 14(21.2%) and the least isolated bacteria were *Pseudomonas aeruginosa* and *Staphylococcus aureus*. In conclusion, although the majority of isolated bacteria were common normal flora of the ear, however a few pathogens were isolated as well. So, it is very important to educate the people with hearing aids earmoulds about proper cleaning and disinfection procedure to prevent any serious ear canal infection.

Key words: Earmoulds, infection, polybacterial,culture, hearing

INTRODUCTION

There are many causes of hearing loss, among them, mechanical problems in the external ear canal or middle ear are important due to blockage of the conduction of sound (Anonymous, 2003). The most common cause of conductive hearing loss in the middle ear, especially in children, is an accumulation of fluid as a result of ear infections or conditions such as allergies or tumors that block the eustachian tube, which drains the middle ear (Fireman, 1997; Vourexakis *et al*., 2010). Young children commonly have some degree of conductive hearing loss after an ear infection (otitis media), because infection may lead to accumulation of fluid (effusion) in the middle ear. Most children regain normal hearing in 3 to 4 weeks after the infection resolves, but a few have persistent hearing loss. Chronic, long-standing infections of the middle ear often result in both conductive and sensorineural losses. Hearing loss is more likely in children who have recurring ear infections (Khairi *et al*., 2010).

The normal ear canal contains many organisms such as diphtheroids, Coagulase Negative Staphylococci (CNS) and *Neisserea* sp. (Ahmad *et al*., 2007) and is more prone to bacterial infections than any other part of the body. These organisms can cause opportunistic infection in immune compromised persons (Kemp and Bankaitis, 2000; Bankaitis, 2002). Hearing aid surfaces have been found to have light to moderate amounts of different bacteria and fungi (Bankaitis, 2002). Each individual hearing aid had a unique array of bacteria creating an ideal opportunity for cross-contamination. Although, cerumen has antibacterial properties, these are less effective in hearing aid users, since the warm, moist environment raises the pH of the ear canal and provides an ideal environment for bacterial growth (Kemp and Bankaitis, 2000).

Otitis externa is most commonly caused by infection (usually bacterial, although occasionally fungal), but it may also be associated with a variety of noninfectious systemic or local dermatologic processes (Battikhi and Ammar, 2004). Fortunately, the external auditory canal has some special defenses. Cerumen creates an acidic coat containing lysozymes and other substances that probably inhibit bacterial and fungal growth. Too little cerumen can predispose the ear canal to infection, but cerumen that is

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excessive or too viscous can lead to obstruction, retention of water and debris and infection (Kelly and Mohs, 1996; Nichols, 1999).

The use of hearing aid earmoulds is a predisposing factor to the development of otitis externa. Aside from the `increased humidity that results from wearing a hearing aid earmold, it has been postulated that the presence of polymicrobial flora in earmoulds may be an etiological agent for the development of otitis externa in human (Ahmad *et al*., 2007). The objective of this study was to determine the presence and nature of bacterial flora on hearing aids earmoulds in a children's population in Ahvaz, Iran.

MATERIALS AND METHODS

The study population consisted of 119 children referred to Imam Ali and Rudaky Schools in Ahvaz, Iran, from October 2007 to April 2008. The majority of samples were collected from Rudaky school (n = 73) and the rest were from Imam Ali school (n = 46). The children consisted of 55 females (46.2%) and 64 males (53.8%), with ages ranging from 6 to 13 years, with a mean of 10.5 years. By using sterile cotton swabs, samples were obtained from both ears of the children by adherence to standard precautions and techniques (Bankaitis, 2002). Three samples were taken from surface of hearing aids earmoulds; canal in hearing aid wearers and ear without hearing aids earmoulds. The swab samples were immediately transferred to the microbiology department and cultured directly onto blood agar and MacConkey agar plates (Hi-Media, Mumbai, India) and were incubated at 37°C for 24 h. The cultures were then examined for bacterial growth; colony characteristics were studied and cell morphology was examined microscopically. According to preliminary examination, necessary standard biochemical tests were performed and the organisms were identified as per standard identification criteria (Forbes *et al*., 2007). For pathogenic bacteria antimicrobial susceptibility test was performed by means of agar disc diffusion method of Kirby Bauer according to the guidelines of National Committee for Clinical Laboratory Standards (2002), using several clinically in-use antibiotics. The Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) was used for data analysis.

RESULTS

The total number of collected samples were 108 from hearing aids earmoulds, 216 from ear canal in hearing aid wearers and 207 from ear without hearing aids earmoulds. In children with hearing aids earmoulds, 60 (55.6%) had the equipment in right ear, 39(36.1%) in left ear and in the remaining nine, the earmoulds were in both ears.

From total samples obtained in children with hearing aids earmoulds, 66 cases (61.1%) were culture positive comprising 41(62.1%) from right ear and 25(37.9%) from left ear. Among samples obtained from ear canal without hearing aids earmoulds 124(52.1%) were culture positive, which 73(58.9%) and 51(41.1%) were from right and left ears, respectively.

Various organisms were recovered from hearing aids earmoulds cultures with the bacterial normal flora as the most common isolated bacteria, along with a few pathogenic bacteria (Table 1). Bacterial contamination were found on the ear moulds of both ears except for one case of contamination in only left ear earmold. The majority of isolated bacteria from earmoulds were CNS 40(60.6%) and Polybacterial flora 14(21.2%) and the least isolated bacteria were *Pseudomonas aeruginosa* and *Staphylococcus aureus*. The results from susceptibility testing for these pathogenic bacteria revealed that the most sensitive antibiotics against *S. aureus* were vancomycin and ofloxacin. Imipenem and meropenem were found to have high bactericidal effect against *Pseudomonas aeruginosa*. However, this bacterium showed fully resistance to vancomycin, clindamycin, ceftriaxone and cefozoline.

Table 2 shows the bacteria isolated from ear canal in hearing aid wearers and ear canal without hearing aids

Table 1: The relative frequency of isolated bacteria from hearing aids earmoulds

	Hearing aids earmoulds		
Isolated bacteria	Right	Left	Total No.
CNS	28 (42.4)	12 (18.2)	40 (60.6)
Staphylococcus aureus	1 (1.5)	1 (1.5)	2 (3)
Diphtheroid	5 (7.6)	3 (4.5)	8 (12.1)
Pseudomonas aeruginosa	1(1.5)	1 (1.5)	2 (3)
Polybacterial			14 (21.2)
CNS+Diphtheroid	5 (7.6)	5 (7.6)	10 (15.2)
CNS+*Bacillius cereus*	1 (1.5)	2 (3)	3 (4.5)
CNS+*Neisseria* sp.	0 (0)	1 (1.5)	1 (1.5)
Total	41 (62)	25 (38)	66 (100)

CNS: Coagulase Negative Staphylococci. Values in brackets indicate percentage

Table 2: The relative frequency of isolated bacteria from canal in hearing aid wearers and ear without hearing aids earmoulds

Isolated bacteria	Ear with aid	Ear without aid	Total No.
CNS	48 (38.7)	35 (28.3)	83 (67)
Staphylococcus aureus	1 (0.8)	1 (0.8)	2 (1.6)
Diphtheroid	13 (10.4)	10 (8.1)	23 (18.5)
Pseudomonas aeruginosa	1 (0.8)	1 (0.8)	2 (1.6)
Polybacterial			14 (11.3)
CNS+Diphtheroid	7 (5.6)	3 (2.5)	10 (8.1)
CNS+*Bacillius cereus*	1 (0.8)	0 (0)	1 (0.8)
CNS+*Neisseria* sp.	2 (1.6)	1 (0.8)	3 (2.4)
Total	73 (59)	51 (41)	124 (100)

CNS: Coagulase negative Staphylococci. Values in brackets indicate percentage

earmoulds. Similar to results of earmoulds culture, CNS was the most common isolated bacteria followed by Diphtheroid 23(18.5%) and Polybacterial flora 14(11.3%).

DISCUSSION

A wide range of bacteria and fungi have been found to grow on hearing aid surfaces. Some of the bacteria are consistent with what is normally found in the ear but many of the recovered bacteria are not and are considered unhygienic. Since, some of these bacteria are not part of the ear's normal environment, they can potentially irritate the lining of the ear canal and cause itching, redness, swelling, pain, or result in ear odor (Bankaitis, 2005). On the other hand, the establishment of these uncommon bacteria may cause more serious conditions in children. Among them, acute otitis externa is a common presenting disorder seen in many primary care offices (Daneshrad *et al*., 2002; Ong and Chee, 2005) and with less frequency chronic suppurative otitis media (Nikakhlagh *et al*., 2008).

Present finding revealed that, 66 cases of hearing aids earmoulds and 124 cases of canal in hearing aid wearers contained bacteria which were identified by culture. The bacterial contamination rate was found to be higher in children from Rudaky school probably due to the higher number of children tested in this school. However the difference was not significant.

The majority of hearing aids were contaminated with at least one bacterium and the other contained two independent bacteria. The CNS were found on the surface of 46 hearing aids or hearing instruments and 83 of canal in hearing aid wearers. These were accompanied with other microorganisms, from the external auditory canal. The bacterial contamination rate of the studied earmoulds were 55.4% and about half of earmoulds showed no contamination. This was lower than the contamination rates of earmoulds reported in similar studies as 70.5, 82.3 and 90% (Jahn and Hawke, 1992; Sturgulewski *et al*., 2006; Bankaitis, 2002). These reports were represented microbial contamination including funal, while in present study we have reported the bacterial contamination rate only and this may well explained the contradiction between our finding with above mentioned studies. But in concordant, they were reported CNS as the most common isolated organism from hearing aids and canal in hearing aid wearers. There are more recent studies which have emphasized on CNS as the most prevalent organisms recovered from hearing moulds based on their findings (Powell *et al*., 2003; Ahmad *et al*., 2007).

We found no significant differences between microbial flora recovered from canal of hearing aid wearers and ear without hearing aids earmoulds. Despite the predominance of recovered microbial normal flora in this study, a few isolated bacteria: *Staphylococcus aureus* and *Pseudomonas aeruginosa* which are extremely virulent were also recovered from hearing aids and canal in hearing aids wearers. In an investigation, light to heavy amounts of microbial growth were found on hearing aid surfaces, which included both expected and unexpected strains of bacteria and/or fungi (Bankaitis, 2002). While some of the reported recovered microorganisms were consistent with what would be expected to be found in the external auditory canal, however, several of the virulent microorganisms such as *Staphylococcus aureus* and *Pseudomonas aeruginosa* were also isolated. Furthermore , several hearing aids were contaminated with light to heavy amounts of bacteria such as *Enterococci* which is specifically found in fecal matter. In another study, the predominant organism recovered was CNS, found on 12 of 17 hearing aids. Five other bacteria and three unidentifiable fungi were recovered from most of the hearing instrument surfaces. A small number of hearing aids (3/17 or 17%) came back negative from the laboratory, indicating no microbial growth (Sturgulewski *et al*., 2006). In contradiction to their study, our contamination rate was lower and some half of our earmoulds showed no bacterial growth.

In conclusion, the most common isolated organisms were CNS and Polybacterial flora. *Staphylococcus aureus* and *Pseudomonas aeruginosa* as pathogenic bacteria were isolated at a lower rate from both surface of hearing aid equipments and canal in hearing aid wearers and ear without hearing aids earmoulds. Recent researches related to hearing aid hygiene has shed new light on how patients need to clean their hearing aids and/or earmoulds (Bankaitis, 2002; Charuhas, 2009). According to their statement, Hearing aids and earmolds need a regular cleaning to keep them in top working condition. Earmolds and tubing must be kept free of wax and debris to ensure optimal hearing results. So, it is very important to educate the people with hearing aids or earmoulds about proper cleaning and disinfection procedure to prevent any serious ear canal infection.

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