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Case Series

A prospective study of seven patients with chronic mastoiditis

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Introduction: Chronic mastoiditis is generally a result of chronic suppurative otitis media; it is rarely a result of failure of treatment of acute mastoiditis.

Case presentation: Seven patients with chronic mastoiditis were investigated. Four patients had bilateral mastoiditis. The duration of illness ranged from 1 to 45 years. A comparison between operative and external auditory canal cultures was performed. The operative specimens were obtained directly from the infected mastoids. The external ear and mastoid specimens were inoculated and cultivated immediately by bedside. All cases showed positive bacterial cultures. The growth was monomicrobial in two cases and polymicrobial in five cases. Seventeen isolates were recovered (11 aerobes and six anaerobes). *Pseudomonas aeruginosa* was the most predominant isolate (23.5 %) and was recovered from four patients (57 %). This high prevalence may be related to misuse of ear drops that transmit this organism from skin flora towards the mastoid. The anaerobes were isolated from four patients. This may indicate a significant role of anaerobic bacteria in producing chronic mastoiditis that would not respond to usual treatment measures.

Conclusion: Cultures from external ear canal discharge might be used as a source for isolation of bacteria causing chronic mastoiditis and chronic otitis media provided that the specimen was collected and cultivated properly. They revealed sensitivity (88 %), specificity (100 %), positive predictive value (100 %) and negative predictive value (66 %). In anaerobic cultures, the sensitivity was 66.7 %. No previous studies were found with regard to evaluation of the reliability of external ear culture for isolation of the causative agents of chronic mastoiditis or chronic otitis media.

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Introduction

Mastoiditis is an inflammatory process of the mastoid air cells in the temporal bone (Glynn *et al.*, 2008). Chronic mastoiditis is generally a result of chronic suppurative otitis media; it is rarely a result of failure of treatment of acute mastoiditis (Brook, 2009). Chronic suppurative otitis media is persistent inflammation of the middle ear or mastoid cavity. Synonyms include 'chronic otitis media (without effusion)', chronic mastoiditis and chronic tympanomastoiditis. Chronic suppurative otitis media is characterized by recurrent or persistent ear discharge (otorrhoea) over 2–6 weeks through a perforation of the tympanic membrane (Acuin, 2007). Two types of mastoiditis are associated with bone destruction: acute coalescent mastoiditis and chronic mastoiditis with osteitis. Acute coalescent mastoiditis generally follows a severe bout of acute otitis media (Myer, 1991). Inadequate treatment of acute otitis media may result in a clearing of the middle ear portion of the infection, with persistence of infection somewhere within the adjoining pneumatized spaces in the mastoid. This 'masked mastoiditis' occurred in 15 % of cases in the early antibiotic era (Smeraldi, 1947) and, although uncommon, still occurs today (Yorgancılar et al., 2013). The illness is common in resource-poor countries and those with poor socio-economic status (Acuin, 2007). The effective control of acute otitis media has reduced the number of cases of acute coalescent mastoiditis, but the incidence of chronic mastoiditis caused by cholesteatoma has not been decreased with antibiotic usage (Parisier, 1989). The occurrence rate of mastoiditis was found to be higher in countries with restricted antibiotic use (Van Zuijlen *et al.*, 2001).

Few cases of acute mastoiditis develop into chronic ones, whereas few cases of acute otitis media result in chronic

suppurative otitis media. Furthermore, mastoidectomy is rarely indicated for chronic mastoiditis as a treatment option, which was mandatory for included cases in the present work. The external ear had to contain discharging material in order to be included in the present study. Therefore, there were very few cases that could be involved according to the present study criteria.

There is a traditional view that chronic otitis media and chronic mastoiditis must exist in the presence of tympanic membrane perforation (Paparella *et al.*, 1980). Chronic suppurative otitis media involves a cycle of inflammation, ulceration, granulation and infection in the middle ear. There is conductive hearing loss and often inflammation of the mastoid cavity. Complications include hearing loss, mastoiditis, cholesteatoma, facial nerve paralysis, meningitis, brain abscess and sigmoid sinus thrombosis (Benson & Mwanri, 2012).

Anaerobic bacteria are important pathogens in head and neck infections such as chronic otitis media, chronic sinusitis, chronic mastoiditis, head and neck abscesses, cervical adenitis, parotitis, and post-operative infection (Brook, 1992).

The aims of the present study were to investigate the microbiological and clinical aspects of chronic mastoiditis and the reliability of external ear cultures for isolation of the causative agents.

Patients and methods

The prospective study included seven patients with chronic mastoiditis (four cases had bilateral mastoiditis whereas three cases had unilateral mastoiditis). The seven cases were collected during a period of 18 months. Inclusion criteria for the study were cases having mastoidectomy with a discharging ear. An eighth case was excluded from the study because the operative specimen revealed a negative culture whilst the external auditory canal specimen yielded a positive culture. The study was conducted at Basrah University Teaching Hospital, Iraq. The study was approved by the Local Research Ethics Committee of College of Medicine, University of Basrah, and the patients or their guardians signed an informed consent for operative intervention. The patients' ages ranged from 15 to 60 years (mean 37 years). Three patients were male. The duration of illness ranged from 1 to 45 years (mean 15 years). All patients presented with intermittent purulent ear discharge and perforated tympanic membranes. The illness started as acute otitis media during childhood in three patients, whereas in the other four cases the acute illness started during adulthood. Four patients presented with bilateral chronic mastoiditis. One patient had sickle cell anaemia. The socio-economic status was poor in five cases. All patients showed a normal temperature at the time of surgical operation and specimen collection. All cases revealed radiological signs of sclerosis of mastoid air cells, whilst four cases had cholesteatomas. They had used systemic antibiotics and local antibiotic ear drops during certain times of their illness.

A specimen cannot be obtained directly from the infected mastoid or middle ear unless the patient undergoes an operative procedure. For this reason, the specimen for culture has to be collected from the external ear in patients who had no indication for surgery. The purulent material of the infected mastoid has a route to the middle ear and then to the external auditory canal. Therefore, cultures of material obtained from external auditory canal, as compared with cultures from the mastoid, were examined to evaluate the efficiency of external ear cultures for isolation of causative agents of mastoiditis, thus verifying whether the isolated organisms by culture from the external ear canal were a reliable or unreliable source for identification of the causative agents of chronic mastoditis or chronic otitis media.

The material for bacterial culture was collected directly from the mastoid during surgery, which was regarded as the standard specimen. Just before mastoidectomy, another comparative material was obtained from the discharge in the external auditory canal. This was performed after cleaning the external ear orifice with antiseptic (tincture iodine), but without the removal of deeply seated pus in the external ear canal. The antiseptic was used to prevent contamination of the cotton swabs with normal skin flora during their introduction into external auditory canal. The cotton swab was introduced as far as possible into the external ear for pus collection with avoidance of contact of the cotton swab with normal skin of the external ear. The operative material was collected by cotton swab and/or a piece of infected tissue. The operative and external ear specimens were inoculated and cultivated immediately (by the bedside) on aerobic and anaerobic culture media. This rapid inoculation and cultivation method secured the isolation of strict anaerobic organisms and prevented the overgrowth of contaminants within pus material, especially from external ear specimens. Aerobic and anaerobic micro-organisms were identified using conventional methods.

For statistical methods, the following definitions were applied: *sensitivity* was defined as the number of external ear isolates agreeing with operative cultures divided by the number of operative isolates; *specificity* was the number of patients with negative results by both operative and external ear cultures divided by the number of patients with negative results from operative cultures; *positive predictive value* was the number of external ear isolates agreeing with the operative cultures divided by the total number of external ear isolates; and *negative predictive value* was the number of true negative external ear isolates divided by the total number of negative external ear isolates.

Results

All cases yielded positive bacterial cultures. The operative procedures and microbiological investigations were performed for only one side in the four cases with bilateral mastoiditis. The growth was monomicrobial in two cases

Table 1. Bacterial isolates recovered from the mastoids in the seven cases

Micro-organism	No. (%)
Aerobic	
Pseudomonas aeruginosa	4 (23.5)
Proteus sp.	3 (17.6)
Coagulase-negative staphylococci	2 (11.8)
Klebsiella aerogenes	1 (5.9)
Escherichia coli	1 (5.9)
Anaerobic	
Prevotella melaninogenica	2 (11.8)
Bacteroides fragilis	1 (5.9)
Peptostreptococcus micros	1 (5.9)
Peptostreptococcus magnus	1 (5.9)
Fusobacterium sp.	1 (5.9)
Total	17 (100)

(28.6 %) and polymicrobial in five cases (71.4 %). The total number of isolates was 17: 11 were aerobic (64.7 %) and six were anaerobic (35.3 %). *Pseudomonas aeruginosa* was the most frequent isolate (23.5 %) (Table 1). It was recovered from four patients (57 %). This organism was followed by *Proteus* sp. (17.6 %), coagulase-negative staphylococci (11.8 %), *Klebsiella aerogenes* (5.9 %) and *Escherichia coli* (5.9 %).

The anaerobic bacteria were isolated from four patients (57 %). *Prevotella melaninogenica* was the most common anaerobic isolate (11.8 %), whereas the other anaerobes constituted 5.9 % for each organism (Table 1).

The external ear canal cultures revealed a sensitivity of 88 %, a specificity of 100 %, a positive predictive value of 100 % and a negative predictive value of 66 % for aerobic and anaerobic bacteria. The sensitivity was 66.7 % with regard to the isolation of anaerobes (Table 2). The sensitivity was 100 % for aerobic cultures. Four patients were taking antibiotic treatment before the surgical intervention. Additional data about the patients is shown in (Table 3).

Discussion

In the previous literature, by searching the entire databases in June 2015, there was no study found that carried out a comparison between the micro-organisms that are recovered from mastoid bone and those recovered from external ear discharge. Chronic mastoiditis is very rare condition for which operative intervention is indicated for few cases. The vast majority of previous studies of chronic mastoidtis were retrospective in which data were obtained from hospital medical records of a number of years of duration. A retrospective study was conducted at Malaysian Tertiary Medical Center from June 1996 to December 2003, where there were only 63 cases with chronic otitis media and mastoiditis that required mastoidectomy (Abdullah *et al.*, 2013).

Pseudomonas aeruginosa was the most predominant pathogen recovered in the present study (23.5 %) that isolated from four patients (57 %), which was followed by Proteus sp., coagulase-negative staphylococci, and *Prevotela melaninogenica*. *Pseudomonas aeruginosa* is a known member of normal skin flora (Brooks *et al.*, 2010). This high prevalence may be related to improper use of antibiotic ear drops that transmit this organism from skin into middle ear and mastoid. It is also highly resistant to most antibiotics of common use that can cause chronic infection. In a previous review of chronic suppurative otitis media, the most commonly isolated micro-organisms were *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Verhoeff *et al.*, 2006). *Pseudomonas aeruginosa* has been particularly implicated in the causation of bony necrosis and mucosal disease. Coagulase-negative staphylococci are also part of normal cutaneous flora that can be transmitted to mastoid by the same way. In a previous study of chronic mastoiditis, *Proteus mirabilis* was found to be the most common organism isolated (Elango & Than, 1995) which was followed by *Pseudomonas aeroginosa*, and *Staphylococcus aureus*. An Indian study involving chronic suppurative otitis media with cholesteatoma among children, the most common isolated organisms were *Pseudomonas aeruginosa*, *Proteus mirabilis* and *S. aureus* (Madana *et al.*, 2011). In a study on Saudi population of chronic suppurative otitis media, the most frequent organisms isolated were *S. aureus*, and *Pseudomonas aeruginosa* followed by coagulase-negative staphylococci, and *Proteus mirabilis* (Ahmad, 2013). In a study that investigated aerobic bacteriological agents of chronic suppurative otitis media, *Pseudomonas aeruginosa* was the most predominant species

Table 2. Diagnostic value of external ear cultures in relation to operative cultures in chronic mastoiditis

Micro-organism	Total no. isolates	No. operative isolates	External ear cultures						
			No. agreeing with operative cultures	False negative	False positive	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Aerobic	11	11	11	0	0	100	100	100	100
Anaerobic	6	6	4	2	0	66.7	100	100	66
Total	17	17	15	2	0	88	100	100	66

Table 3. Data for seven patients with chronic mastoiditis

No.	Age (years)	Sex	Socio-economic level	Site	Duration of illness (years)	Pre-operative antibiotics in use	Operative specimen	Operative culture	External ear culture
1	60	Male	Poor	Left ear	1	Nil	Swab	*Klebsiella aerogenes*	*Klebsiella aerogenes*
2*	38	Female	Poor	Left ear	10	Cloxacillin (oral)	Swab	Coagulase-negative staphylococci	Coagulase-negative staphylococci
3	40	Female	Poor	Bilateral†	33	Parenteral procain penicillin and gentamicin	Swab, necrotic material	Proteus sp., *Pseudomonas aeruginosa*, *Bacteroides fragilis*	Proteus sp., *Pseudomonas aeruginosa*, *Bacteroides fragilis*
4	50	Male	Poor	Bilateral†	45	Rifampicin (oral), gentamicin ear drops	Swab	*Pseudomonas aeruginosa*, coagulase-negative staphylococci, *Prevotela melaninogenica*	*Pseudomonas aeruginosa*, coagulase-negative staphylococci, *Prevotela melaninogenica*
5	25	Female	Good	Right ear	1	Nil	Swab, necrotic material	*Pseudomonas aeruginosa*, *E. coli*, Proteus sp.	*Pseudomonas aeruginosa*, *E. coli*, Proteus sp.
6	32	Female	Good	Bilateral†	7	Nil	Swab	Proteus sp., *Prevotela melaninogenica*, *Peptostreptococcus micros*, Fusobacterium sp.	Proteus sp., *Peptostreptococcus micros*
7	15	Male	Poor	Bilateral†	7	Ampicillin (oral), gentamicin ear drops	Swab	*Pseudomonas aeruginosa*, *Peptostreptococcus magnus*	*Pseudomonas aeruginosa*, *Peptostreptococcus magnus*

* Patient with sickle cell anaemia.
† Mastoidectomy and microbiological study was carried out on one side in all cases with bilateral mastoiditis.

(40 %), followed by *Staphylococcus aureus* (31 %), *Escherchia coli* (12 %), Proteus sp. (5 %) Klebsiella sp. (5 %), and negative cultures (7 %) (Shyamala & Reddy, 2012).

Anaerobes are the predominant components of oropharyngeal mucous membranes bacterial flora, and are therefore a common cause of bacterial infections of endogenous origin of upper respiratory tract and head and neck including mastoiditis (Brook, 2012). In the present study, anaerobic bacteria were isolated from 57 % of patients (35.3 % of the total number of isolates). *Prevotela melaninogenica and* Peptostreptococcus species were the predominant anaerobic causative agents. Two studies were carried out by Mousa (1997) and Mousa *et al.* (1996) concerning anaerobic bacterial infection. They found that the high rate of recovery of anaerobes was related to immediate inoculation and cultivation of material under anaerobic condition by bedside whilst delayed handling of the specimens may lead to loss of strict anaerobes. Furthermore, delayed cultivation also might predominate overgrowth of contaminants in cases where the specimens are obtained from external ear canal. Brook (2005) had also emphasized that anaerobes predominate in studies of chronic mastoiditis where adequate methods for their isolation are employed. The high prevalence of anaerobes may indicate a significant role of these bacteria in producing chronic infection that does not respond to ordinary treatment regimens. The pathogenicity of anaerobic organisms is expressed through their ability not only to survive penicillin therapy but also to shield penicillin-susceptible pathogens from the drug (Brook, 1992). Many of previous studies of acute or chronic mastoiditis did not mention any anaerobic isolates or routine anaerobic cultures might not be performed (Elango & Than, 1995; Madana *et al.*, 2011; Shyamala & Reddy, 2012). One isolate alone of Bacteroids species (0.6 %) was recovered in a study on chronic suppurative otitis media (Ahmad, 2013). Most previous studies have reported the recovery of anaerobes from about 50 % of patients with chronic otitis media and those with cholesteatoma. The most frequent anaerobes were Gram-positive cocci, pigmented Prevotella, Porphyromonas species, Bacteroides species and Fusobacterium species (Brook & Burke, 1992). In a review study on chronic suppurative otitis media, the most frequently isolated anaerobic organisms were Peptostreptococcus species, Fusobacterium species, pigmented Prevotella, and Porphyromonas species (Brook, 2008).

Mycobacterium tuberculosis is a well-documented pathogen in otitis media and mastoiditis. Its prevalence is increasing due to in part to the rising incidence of immunocompromised hosts (Oberdorfer *et al.*, 2012; Mousa, 1998). Therefore, material from external ear canal could be considered as a good source for mycobacterial isolation. In study performed in Iraq, Mousa (1998) found that active flowing material from a sinus (as comparable to external ear discharge) was more effective for isolation of mycobacteria than the operative specimen, which obtained directly from the infected bone or joint (as comparable to mastoid specimen).

From the data of the present work, external ear discharge culture could be used for isolation of the causative agents of chronic mastoiditis and chronic otitis media provided that the specimen is collected, inoculated and cultivated properly as described in the present study. However, the sensitivity was low (66.7 %) in regard to isolation of anaerobic micro-organisms. This may be related to lethal effect of the oxygen on the anaerobic bacteria in the external auditory canal that lead to missing of anaerobes on culture. It is also concluded that there is high prevalence rate of anaerobic bacteria in chronic mastoiditis and chronic otitis media. It is recommended, therefore, to make routine aerobic and anaerobic cultures for all cases.

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