

Outcome of bacterial culture from mastoid granulations: is it relevant in chronic ear disease?

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Abstract

Objective: To detect the presence of bacteria in mastoid granulations and compare its prevalence in both types of chronic suppurative otitis media (CSOM). To find out if stage of disease activity, age, duration of disease, and aditus patency relate to obtaining positive cultures.

Study design and setting: A prospective, parallel group study done at a tertiary care referral centre. Mastoid granulations from 79 patients with CSOM undergoing mastoidectomy were processed for anaerobic and aerobic bacteria.

Results: Aerobes were isolated from 57.55 per cent of the tubotympanic and 74.4 per cent of atticoantral disease ($p = 0.18$). Anaerobic cultures were positive in one case from each group. Monomicrobial growth was detected in 37.5 per cent of tubotympanic and 48.5 per cent of atticoantral disease. Polymicrobial growth occurred in 20 per cent and 25.6 per cent in the tubotympanic and atticoantral groups, respectively. The predominant aerobic isolate was coagulase negative *Staphylococcus*, followed by *Pseudomonas aeruginosa*, *Staphylococcus aureus*, non-fermenting Gram-negative bacteria, *Enterobacter* and *Enterococcus*, *Proteus* species, *Citrobacter*, non-pathogenic *Neisseria*, aerobic spore formers were grown only in atticoantral disease. A single isolate of *Aspergillus* was grown. Correlating the state of disease activity of the ears with positive mastoid granulation cultures, six out of the eight inactive ears were culture positive along with seven out of the nine active and 10 out of the 23 quiescent ears. Positive mastoid granulation cultures were obtained in 60 per cent of those with blocked aditus and 42.9 per cent with patent aditus.

Conclusion and significance: In this study, we found that mastoid granulations are not sterile but harbour polymicrobial pathogens. Positive cultures were obtained irrespective of stage of disease activity, age, duration of disease and aditus patency. The pattern of organisms cultured from safe and unsafe CSOM and also from ears in active, quiescent and inactive stages, were similar. These findings suggest that these organisms may be responsible for mastoid granulations. We also noted that positive cultures had no statistical correlation with aditus patency and duration of disease. We suggest further studies to evaluate the significance of asymptomatic mastoid granulations harbouring organisms and whether opening the mastoid antrum and achieving aditus patency, irrespective of the stage of disease activity, will help improve the long-term surgical outcome and also prevent recurrence of ear discharge.

Key words: Otitis Media; Suppurative; Granulation Tissue; Bacterial; Cholesteatoma; Mastoid

Introduction

Studies have shown that an obstructed aditus ad antrum (aditus block), can potentially lead to the development of pathological tissue in the mastoid cavity.^{1,2} The prevalence of granulations in chronic otitis media (COM) was found to be as high as 97 per cent in the 144 temporal bones studied by Da Costa *et al.*² Several authors have advocated clearing the mastoid of granulations prior to closure of a perforation and at the same time making the aditus patent, thus providing a reservoir of air to prevent retraction of the neotympanum.^{3–6}

Although ear discharge has been widely researched,^{7–12} there is a paucity of studies on bacteriology of mastoid granulation tissue.¹³ In as early as 1965, Palva *et al.* in their bacteriological study of chronic suppurative otitis media (CSOM), analysed flora from middle-ear aspirates pre-operatively, fluid in the mastoid or antral tissue intra-operatively as well as exudates from the canal post-operatively. The mastoid was infected with the same organism as the middle ear in patients with a large cholesteatoma or in ears where there was an open communication between the mastoid and middle

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ear. If cholesteatoma or granulations had caused an aditus block, specimens from the periantral area were found to be sterile.¹³

This study summarizes our experience in the culture of microorganisms from mastoid granulations in patients undergoing surgery for CSOM atticoantral disease (AAD) and tubotympanic disease (TTD) in various stages of activity (active, quiescent and inactive stages) and its correlation to age, duration of disease and aditus patency. Based on the organisms cultured, guidelines for the choice of antibiotics, the need to perform a mastoidectomy and to clear the aditus were looked into.

Materials and methods

The sample size was calculated using the results of a preliminary study on 20 cases of CSOM, 11 with TTD and nine with AAD having granulations in their antrum. Fourteen positive cultures were obtained, six (55 per cent) from TTD and eight (89 per cent) from AAD. Assuming a type I error of 5 per cent and with power of 80 per cent the minimum sample size needed was estimated as 34 in each group. These 20 pilot study patients were included in the final analysis.

This prospective study was done on 79 consecutive patients with CSOM TTD and AAD who underwent mastoid surgery, and had granulations in the antrum. In the TTD group (Table I) there were 13 females and 27 males, aged 8–65 years (mean age 30.7 years). The AAD group consisted of 15 females and 24 males, aged 6–51 years (mean age 22.4 years). Aerobic and anaerobic cultures were done on the tissue obtained from the mastoids. Patients with complications of CSOM, those requiring revision surgery and in immunocompromised conditions were excluded from the study.

Techniques employed

Except in three cases, surgery was performed under general anaesthesia. The mastoid cortex was exposed either post-aurally or endaurally and the temporalis fascia graft harvested. Following antrotomy,

TABLE I
DESCRIPTION OF CASES

	Tubotympanic (n = 40) No. (%)	Atticoantral (n = 39) No. (%)
Age in years		
<20	13 (32.8)	20 (51.3)
21–30	10 (25.0)	11 (28.2)
>31	17 (32.5)	8 (20.5)
Sex		
Male	27 (67.5)	24 (61.5)
Female	13 (32.8)	15 (38.5)
Duration in years		
<5	8 (20.0)	14 (35.9)
6–19	24 (60.0)	18 (46.2)
>20	8 (20.0)	7 (17.9)
Site of disease		
Unilateral	22 (55.0)	22 (86.4)
Bilateral	18 (45.0)	17 (43.6)
Aditus patency		
Blocked	33 (82.5)	32 (82.0)
Patent	7 (17.5)	7 (18.0)

TABLE II
COMPARISON OF CULTURE RESULTS

Culture	Tubotympanic No. (%)	Atticoantral No. (%)
Aerobic culture		
Positive	23 (57.5)	29 (74.4)
Negative	17 (42.5)	10 (25.6)
Anaerobic culture		
Positive	1 (2.5)	1 (2.8)
Negative	39 (97.5)	38 (97.4)

harvesting of granulation tissue was done using micro cup forceps and inoculated into 1 ml of sterile normal saline for aerobic culture and directly into sodium thioglycolate broth media for anaerobic cultures.

If granulation tissue was seen in the antrum, a complete mastoidectomy was done using standard microsurgical instruments and a micro drill. The aditus was made patent when obstructed. Simultaneous tympanoplasty procedures were carried out.

If aerobic cultures were negative after overnight incubation the plates were further incubated for 24 hr. Anaerobic cultures were observed for two weeks. Sensitivity of the organisms to various antibiotics was also done.

Pre-operatively, antibiotics were avoided, except for two patients with cardiac disease who needed peri-operative antibiotic cover as part of infective endocarditis prophylaxis.

Statistical analysis

The rate of positive mastoid tissue cultures was compared with the negative. The cultures in the two groups (TTD and AAD) were compared by chi-square test and Fisher’s exact test where appropriate.

Results

Aerobic microbes were grown from granulations in 57.5 per cent of the TTD group and 74.4 per cent of the AAD group (Table II). This difference was not statistically significant. Of the 79 anaerobic cultures done, only two were positive – both diphtheroids, one from each group. Microbial growth pattern presented in Table III shows that the TTD group had no growth in 42.5 per cent, monomicrobial growth in 37.5 per cent and polymicrobial growth in 20 per cent while in the AAD group, 25.6 per cent showed no growth, 48.5 per cent monomicrobial and 25.6 per cent polymicrobial.

The two patients with coexisting cardiac disease, despite being on peri-operative antibiotic cover, had positive culture results.

TABLE III
MICROBIAL GROWTH PATTERN

Growth pattern	Tubotympanic (n = 40) No. (%)	Atticoantral (n = 39) No. (%)
No growth	17 (42.5)	10 (25.6)
Monomicrobial	15 (37.5)	19 (48.5)
Polymicrobial	8 (20.0)	10 (25.6)

TABLE IV
CASE DESCRIPTION AND CULTURE RESULTS

	Tubotympanic (<i>n</i> = 40)		Atticoantral (<i>n</i> = 39)	
	Positive No. (%)	Negative No. (%)	Positive No. (%)	Negative No. (%)
Age in years				
<20	8 (61.5)	5 (38.5)	17 (85.0)	3 (15.0)
21–30	6 (60.0)	4 (40.0)	8 (72.7)	3 (27.3)
>31	9 (52.9)	8 (47.1)	4 (50.0)	4 (50.0)
Duration in years				
<5	4 (50.0)	4 (50.0)	8 (57.1)	6 (42.9)
6–19	15 (62.5)	9 (37.5)	16 (88.9)	2 (11.1)
>20	4 (50.0)	4 (50.0)	5 (71.4)	2 (28.6)
Site of disease				
Unilateral	13 (59.1)	9 (40.9)	17 (77.3)	5 (22.7)
Bilateral	10 (55.6)	8 (44.4)	12 (70.6)	5 (29.4)
Disease stage				
Inactive	6 (75.0)	2 (25.0)	–	–
Quiescent	10 (43.5)	13 (56.5)	–	–
Active	7 (77.8)	2 (22.2)	–	–
Aditus patency				
Blocked	20 (60.6)	13 (39.4)	22 (68.8)	10 (37.2)
Patent	3 (42.9)	4 (51.1)	7 (100)	–

Correlation of culture results of the two groups and the characteristics of the patients are given in Table IV. Though there was an increase in the prevalence of positive culture with duration of disease in years, it was not statistically significant.

Aditus patency

In our study, aditus patency was established based on irrigation and through flow. The aditus was blocked in 33 per cent with TTD and 32 per cent with AAD. In the TTD group, 60.6 per cent of those with blocked aditus and 42.9 per cent with patent aditus had positive mastoid tissue cultures, but the difference was not statistically significant. In the AAD group, 68.8 per cent with blocked aditus and 100 per cent with patent aditus were culture positive, again the difference was statistically insignificant.

Stage of disease

In the TTD group, the state of activity of the ear and its correlation with positive mastoid granulation culture were analysed. Seven out of nine active ears, 10 out of 23 quiescent ears and six out of eight inactive ears were culture positive. The surprising result was that, out of the eight in the inactive group, five ears were dry for more than 1.5 years, yet three of these grew aerobes of which two had two organisms each.

Bacterial identification

The growth patterns were comparable in the two groups, except for *Proteus*, which was not cultured from the TTD group. Gram-negative bacteria cultured were *Pseudomonas aeruginosa* 14 (19.4 per cent), *Proteus* species 8 (11.1 per cent), non-fermenting Gram-negative bacilli 8 (11.1 per cent), *Enterobacter* 5 (6.94 per cent), *Citrobacter* 1 (1.38 per cent), and non-pathogenic *Neisseria* 1 (1.38 per cent). Gram-positive bacteria were coagulase negative *Staphylococci* 18 (25 per cent), *Staphylococcus aureus* 12 (16.46 per cent), *Enterococci* 3 (4.16 per cent) and *Streptococcus* 1 (1.38 per cent). From one mastoid an

aerobic spore former of doubtful significance was cultured. Also, *Aspergillus* species was isolated from one mastoid. On analysing the sensitivity pattern it was seen that 5 (9.6 per cent) organisms were sensitive to a single drug and 41 (78.8 per cent) to more than two drugs.

Discussion

This study illustrates the presence of pathogenic bacteria in granulation tissue from the mastoid in cholesteatomatous and non-cholesteatomatous ears. Positive cultures were obtained from mastoid granulations in 57.5 per cent of the TTD group and 74.4 per cent of the AAD group, regardless of age, duration of disease, aditus patency and more significantly, the stage of disease activity. In five patients there were granulations in the mastoid despite the ear being clinically dry for more than 18 months (inactive stage) and three of these grew organisms.

The organisms cultured from the two groups are similar except for *Proteus* which was not cultured from the TTD group. Further the different stages of disease activity (active, quiescent and inactive) did not seem to influence the pattern of organisms grown from mastoid granulations.

Although the removal of granulation is a fundamental principle of chronic ear surgery, it is sometimes difficult to determine the significance and necessity of treating minimal granulations in a sclerosed mastoid of a dry ear. In silent otitis, granulations have been detected in the mastoid and are known to cause serious intracranial and extracranial complications.¹⁴

The organisms cultured from the granulations in our study were predominantly similar to those from an actively discharging CSOM and seemed to suggest that these organisms were responsible for mastoid granulations, but their actual role in the development of recurrent ear discharge needs to be studied further. The fact that six out of eight inactive ears (i.e. dry for more than six months) and 10 out of 23 quiescent ears

were culture positive seems to support this. It is possible for subclinical infections with minimal ear discharge to go undetected, as patients may not notice the discharge as it dries in the ear canal itself. Hence it would seem prudent to remove all granulations from the mastoid, even if they were minimal. Studies have shown that an obstructed aditus can potentially lead to the development of granulations, but in our study granulations were present in the mastoid irrespective of the patency of the aditus. Aditus block does not appear to lead to granulations and probably mastoid granulations progressively lead to the blocking of the aditus. (In our study, 33 out of 40 with TTD and 32 out of 39 with AAD had blocked aditus caused by granulation tissue, thickened mucosa, squamous epithelium or cholesteatoma.)

Palva *et al.* found that if the matrix of an epitympanic cholesteatoma or a granulation plug separated the middle ear totally from the antrum, specimens from the antrum and the periantral area were sterile,¹³ but in our study 20 (60.6 per cent) of the 33 and 22 (68.8 per cent) of the 32 with blocked aditus grew aerobes.

In 58 actively discharging ears with CSOM, Yamamoto *et al.*¹⁵ took cultures from the tympanic cavity before operation and from the mastoid antrum at surgery. *S. aureus* was the most common organism in the tympanic cavity and *S. epidermidis* in the mastoid antrum. In 32 (55 per cent) of the 58 ears he had examined, bacteria were detected in both the tympanic and mastoid cavities and in 17 ears (53 per cent), the bacterial strains from the two cavities differed. He proposed that mastoid cavity cultures be used as a guideline for the selection of post-operative antibiotics.¹⁵ In our study the prevalence of *Staphylococcus* was highest, followed by *Pseudomonas*, *Proteus* and non-fermenting Gram-negative bacilli.

The role of anaerobes in CSOM has been the subject of much speculation. *Bacteroides melaninogenicus*, *Bacteroides fragilis* and other species have been isolated from 30–56 per cent of cases.^{10,11} Sugita *et al.* isolated them from ears with extensive cholesteatoma or granulation tissue.¹² Yamamoto *et al.* found anaerobic bacteria only from the mastoids of patients with cholesteatoma. In this study the prevalence of anaerobic isolates was very low, only one from each group (2.5 per cent). Possibly, the low prevalence may be attributed to cultures being obtained from granulation tissue that may not have harboured anaerobes.

Candida and *Aspergillus* isolates from mastoid granulations have not been reported in cases of CSOM, although they have been cultured earlier from the middle ear.¹¹ In our study, *Aspergillus* was grown from granulation tissue of one patient, possibly caused by blocked aditus with poor aeration.

Conclusions

Mastoid granulations in chronic ear disease are not sterile but harbour aerobic bacteria in 57.5 per cent of TTD and 74.4 per cent of AAD. Age, duration, aditus patency and stage of disease activity have no

correlation with prediction of positive cultures. Patterns of organisms cultured from safe and unsafe CSOM and also from ears in active, quiescent and inactive stages, were similar. These findings suggest that these organisms may be responsible for mastoid granulations.

We also found that positive cultures had no statistical correlation with aditus patency and duration of disease. We suggest further studies to evaluate the significance of asymptomatic mastoid granulations harbouring organisms and whether opening the mastoid antrum and achieving aditus patency, irrespective of the stage of disease activity, will help improve the long-term surgical outcome and also prevent recurrence of ear discharge.

- **This study looks at the microbial flora found in mastoid granulation tissue in cases of chronic otitis media**
- **Microbial pathogens were found in both cases with and without cholesteatoma**
- **The significance of these findings and their relevance in surgical management are discussed**

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