



The pathology of silent otitis media: A predecessor to tympanogenic meningitis in infants[☆]



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ABSTRACT

Objective: To determine the association of bacteria embedded within a fibrous matrix in the middle and inner ear in infants with tympanogenic meningitis.

Methods: Thirty-one cases with meningitis from the human temporal bone collection at the University of Minnesota were screened to select those with tympanogenic meningitis. Inclusion criteria for tympanogenic meningitis were acute meningitis with histopathological evidence of chronic otitis media, and no other source of infection. The presence of labyrinthitis and pathologic changes such as granulation tissue, fibrosis, cholesterol granuloma, cholesteatoma, tympanic membrane perforation, tympanosclerosis, and the type of effusion were noted. The extent and location of bacteria embedded in a fibrous matrix were also explored.

Results: Seventeen temporal bones, from nine cases that included two females and seven males, ranging in age from five to twenty-three months, met our criteria of tympanogenic meningitis. Eighty two percent of these temporal bones had bacteria within the fibrous matrices (BFM). BFM were located in one anatomical region in one temporal bone and multiple anatomic regions in sixteen temporal bones. The most common locations were the areas near the oval and round windows. They were also commonly seen in the epitympanum, facial recess, and supratubal recess. BFM within the inner ear were observed in the scala tympani and modiolus in the middle and basal turns of the cochleae of nine temporal bones. In one of these temporal bones, BFM were seen in the internal auditory canal. Labyrinthitis was seen in all ears. The tympanic membrane was intact in all cases. BFM were not seen in three temporal bones from two patients. In one case only one side was available for study.

Conclusions: Our findings show an association between the presence of BFM in the ear with chronic pathologic changes and tympanogenic meningitis. Potential pathways of bacteria from the middle ear include hematogenous spread and/or direct spread to dura through the tympanic tegmen, and/or to the inner ear through the oval and round windows, and from there to the modiolus and the meninges. Chronic pathologic changes in the middle ear behind an intact tympanic membrane and the lack of ear symptoms may result in potentially serious sequelae and complications in infant age groups. There should be a heightened awareness of this condition.

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1. Introduction

Otitis media (OM) is a common disease; accounting for more than 16 million doctor office visits in the US in a year [1]. In spite of

the finest medical and/or surgical care, some patients with OM suffer from persistent and recurrent middle ear infections. In addition, intracranial complications of otitis media are not uncommon and can be potentially fatal [2]. Meningitis is the most common intracranial complication of otitis media and carries the risks of life-changing morbidity and death [2]. The mortality rate of tympanogenic meningitis has been reported between 10% and 41% [2–5]. Complications of tympanogenic meningitis are associated with the chronicity of middle ear infection, etiological agents of the infection, the patient's age, and comorbidities [6,7].

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Bacteria within the fibrous matrices (BFM), which are adhered to the mucosal surface and embedded within a matrix of extracellular material, can be associated with the disease progression and persistence of inflammation in chronic otitis media. The fibrous matrix around the bacterial communities can act as a barrier by reducing the clearance of the bacteria by the host immune system. In this study, we investigate the occurrence, frequency, and location of BFM in the middle and inner ear in temporal bones from infants with tympanogenic meningitis. Because human temporal bone studies will allow us evaluate the entire middle and inner ear components, we can see clearly if there is an association between the presence of BFM in the middle and inner ear and tympanogenic meningitis.

2. Methods

Human temporal bones had been previously removed at autopsy. They were fixed in formalin solution, decalcified, embedded in celloidin, and serially sectioned in the horizontal plane from superior to inferior at a thickness of 20 μm . Every 10th section was stained with hematoxylin and eosin and mounted on glass slides for light microscopic observation. Additional sections were stained with Weigert's Gram stain. Case histories were reviewed, and temporal bones from patients who had died of meningitis were selected. Thirty-one cases with meningitis from the human temporal bone collection at the University of Minnesota were screened to select those with tympanogenic meningitis. We excluded cases that had surgery of the temporal bone, leukemia, and other systemic diseases, which might infiltrate into the temporal bone. Of these, 17 temporal bones, from 9 cases that included 2 females and 7 males, ranging in age from 5 to 23 months, met our criteria of tympanogenic meningitis in infants. Meningitis was considered to be of tympanogenic origin if we found clinical and histological evidence of chronic otitis media, indicating that it existed prior to the acute meningitis, with no other source of infection. The presence of labyrinthitis and pathologic changes such as granulation tissue, fibrosis, cholesterol granuloma, cholesteatoma, tympanic membrane perforation, and tympanosclerosis were noted.

BFM composed bacterial aggregates, embedded in a network of fibrous material, were found adjacent to the mucosal surface in temporal bones with chronic silent otitis media. Many rounded bacterial particles were darkly stained with gram Weigert stain for gram-positive bacteria (Fig. 1A and B) and hematoxylin–eosin (H–E). Free-floating bacteria and scattered neutrophils, monocytes, and other inflammatory cells infiltrated in fibrous network were often seen throughout the entire structures. These structures frequently occupied the large areas of the middle or inner ear (Fig. 1A and B).

The following anatomical locations were examined for the presence of BFM: epitympanum, supratubal recess, Eustachian tube, facial recess, sinus tympani, the areas near the oval and round windows, mesotympanum, hypotympanum, aditus ad antrum, mastoid antrum, mastoid cells, inner ear, cochlear aqueduct, and internal auditory canal. Results of blood cultures were documented.

3. Results

Out of 62 temporal bones from 31 cases, 17 temporal bones, from 9 cases that included 2 females and 7 males, ranging in age from 5 to 23 months, met our criteria of tympanogenic meningitis in infants. Eighty-two percent (14/17) of the temporal bones with tympanogenic meningitis had BFM. Gram stains in those BFM cases showed gram-positive bacteria (Figs. 1B; 2A and B). Table 1 shows the findings of the temporal bones with tympanogenic meningitis. BFM were located in 1 anatomical region in 1 temporal bone and within

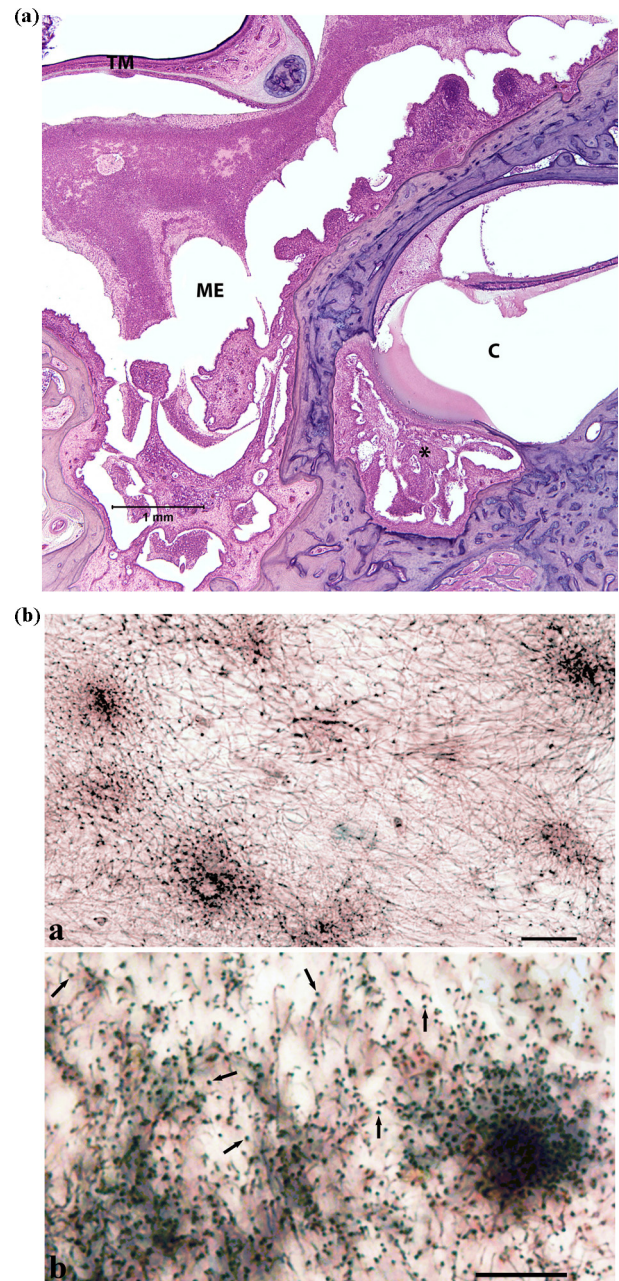


Fig. 1. (A) A lower magnification shows chronic purulent otitis media and bacteria within a fibrous matrix in round window area. Note the thickened sub-epithelial space in the middle ear mucosa (TM, tympanic membrane; ME, middle ear; C, cochlea; * shows location of bacteria within a fibrous matrix) (hematoxylin–eosin). (B) A higher magnification of the area shows bacterial aggregates and single bacteria (arrows) in bacteria within a fibrous matrix revealed with H–E (a) and gram Weigert (b) stains. Bars: 20 μm (a, b).

multiple anatomic regions in 16 temporal bones. The most common locations were oval and round window areas, followed by the epitympanum, supratubal recess and facial recess. BFM within the inner ear were observed in the scala tympani and modiolus in the middle and basal turns of the cochlea of 9 temporal bones. In 1 of these temporal bones, BFM was seen in the internal auditory canal. Labyrinthitis was seen in all patients. The tympanic membrane was intact in all cases. BFM were not seen in 3 temporal bones from 2 patients. In one case, only 1 side was available for the study.

The blood culture results for cases with meningitis were as follows: *Haemophilus influenzae* was positive in 5 cases and *Streptococcus pneumoniae* was positive in 4 cases. During autopsy,

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