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Association of otoscopic findings and hearing level in pediatric patients with otitis media with effusion

Kitirat Ungkanont [a,*], Somrat Charuluxananan [c], Chulaluk Komoltri [b]

[a] Department of Otolaryngology, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Prannok Road, Bangkoknoi, Bangkok 10700, Thailand
[b] Office for Research and Development, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand
[c] Department of Anesthesiology, Faculty of Medicine Chulalongkorn Hospital, Chulalongkorn University, Bangkok, Thailand

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ABSTRACT

Objective: To find the association between the abnormalities of tympanic membrane characteristics and the hearing level in pediatric patients with otitis media with effusion.
Methods: Sixty-three pediatric patients with otitis media with effusion had undergone ear examinations by pneumatic otoscopy to assess the color, transparency, mobility, fluid level and retraction of the tympanic membrane. An audiogram was done in the same setting, average hearing threshold and air-bone gap were measured. Otoscopic findings and the result of the hearing test were analyzed to identify the association between the abnormalities of the tympanic membrane characteristics and elevated hearing threshold.
Results: Hearing loss was found in 92.1% of the patients. Mean hearing level was 31.7 ± 10.3 dB. From linear regression analysis, the patients with dull or opaque tympanic membrane had a significantly higher hearing threshold of 7.2 dB than the patient with translucent ear drum after adjusting for mobility and retraction. The patients with tympanic membrane retraction had a higher hearing threshold of 5.1 dB than the patient who had no retraction after adjusting for transparency and mobility. Mobility had a significant relationship to elevated hearing threshold in the univariate analysis but not in multivariable analysis.
Conclusion: Opacity and retraction were the two characteristics of abnormal tympanic membrane that were associated with elevated hearing threshold in the patients with otitis media with effusion. Hearing test is suggested if opacity or retraction of the tympanic membrane is found.

1. Introduction

Otitis media with effusion (OME) is the type of ear infection without pain and fever. Children usually cannot describe their symptoms caused by the middle ear fluid or decreased hearing and sometimes the history from the parents is unreliable. The decision for the hearing test and the diagnosis of hearing loss may be delayed until the patients come with late presentation. Many diagnostic procedures are used to detect middle ear effusion, ranging from using a simple otoscopy, pneumatic otoscopy, tympanometry and acoustic reflectometry. A meta-analysis for assessment of the accuracy of diagnostic method in otitis media with effusion showed that pneumatic otoscopy had the best performance among eight diagnostic methods [1]. Pneumatic otoscopy gives detailed information about the change of the tympanic membrane and the middle ear in OME. Fluid and inflammation of the middle ear can change the transparency and decrease the mobility of the ear drum. Negative pressure from the inflammation in the middle ear causes retraction of the tympanic membrane towards the promontory. The appearance of fluid can be seen through the tympanic membrane as a change of color, bubbles or fluid level. Retraction, scarring or thickness of the tympanic membrane and middle ear fluid had been studied to have correlation with hearing loss [2–4].

This study is aimed at finding the association between tympanic membrane characteristics (color, transparency, mobility, fluid appearance and retraction) and the hearing level of the patients with OME. One or more of these characteristics may be used as the predictor of elevated hearing threshold so that hearing test can be done in time even in the absence of the patient's symptoms. The presence of conductive hearing loss is important for the decision towards surgical intervention to prevent further damage of the tympanic membrane and to preserve the hearing.

2. Methods

During April 2009 to February 2010, the study was conducted in pediatric patients with otitis media with effusion in a tertiary care

* Corresponding author. Tel.: +66 2 4198040; fax: +66 2 4198044.
E-mail address: raauk@mahidol.ac.th (K. Ungkanont).

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center at the outpatient department of the Pediatric Otolaryngology unit, Department of Otolaryngology, Faculty of Medicine Siriraj Hospital, Bangkok Thailand. The study was approved by the ethical committee and institutional review board of the Faculty of Medicine, Siriraj Hospital, Mahidol University. Suspected cases were recruited for diagnostic screening for OME, those cases were pediatric patients who came in with upper respiratory tract infections, ear problems following upper respiratory tract infections, hearing problems of unknown etiology noticed by parents or teachers, rhinosinusitis, obstructive adenoids, delayed speech and patients referred for hearing screening. Patients with tympanic membrane perforation or tympanostomy tube in place and patients with other causes of conductive hearing loss such as ear trauma or foreign body were excluded.

The history of ear infections and related diseases was taken and standard ear, nose and throat physical examination was performed. Pneumatic otoscopy was done with a Heine Beta 100 otoscope throughout the study. The first author, who is a validated otoscopist and a trained pediatric otolaryngologist, was the single examiner of every patient. Ear examination consisted of cerumen removal, inspection of the tympanic membrane and application of pneumatic pressure. Tympanic membrane findings were recorded in terms of color (pearly gray as normal, red, white, amber or blue as abnormal), transparency (clear/dull), mobility (normal/decreased), middle ear fluid (none, fluid bubble or level, full) and retraction (yes/no). Normal mobility was defined as movement of all part of the tympanic membrane from pneumatic pressure application. Retraction was defined as contact of the tympanic membrane with middle ear structures other than the tympanic annulus, umbo, long process and lateral process of the malleus.

After the physical examination, the patients were sent for audiometry. Madsen conera audiometer was used throughout the study. The audiologist was blinded to the results of the physical examination and the diagnosis. At least three speech frequencies (500, 1000, and 2000 Hz) were measured and recorded for air and bone conduction. Average hearing level and speech reception threshold were recorded. Conductive hearing loss was defined by air-bone gap $\geq$10 dB and hearing level >20 dB.

Outcome measures were the findings of the tympanic membrane from pneumatic otoscopy and the hearing level from audiometry. Descriptive statistics were used to analyze the data from history and physical examinations. Univariate analysis between each characteristic of tympanic membrane findings and the hearing level in decibels was done by *t*-test. Multivariable analysis by linear regression was done to analyze the association between tympanic membrane findings and the hearing level in decibels. Variables selections into the multivariable model were the characteristics with *p*-value <0.2. Statistical significance of the results was defined at *p*-value <0.05. Statistical calculation was done with SPSS version 11.5.

3. Results

Sixty-three pediatric patients were included in the study. There were 43 males (68.3%) and 20 females (31.7%). Mean age was 7.4 ± 3.63 years. Presenting symptoms was shown in Table 1. The most common presenting symptom was an ear problem after an upper respiratory tract infection (46%), followed by hearing problem of unknown etiology (23.8%). Regarding the ear symptoms, 37 cases (58.7%) had ear symptoms, 12 cases (19.0%) complained of ear pain, 14 cases (22.2%) had ear fullness. In 25 cases (39.7%) the parents were aware of decreased hearing. Twenty-six cases (41.3%) had no ear symptoms. Median duration of the ear symptom was 30 days with interquartile range of 91 days. Recurrent OME in the last 12 months was found in 23 cases (36.5%), previous diagnosis of conductive hearing loss from OME was found in 18 cases (28.6%). Diseases associated with OME found in this study were sinusitis in 8 cases (12.7%) and obstructive adenoid in 19 cases (30.2%).

Table 1
Presenting symptoms.

Symptoms	Frequency	Percent
Ear problem after URI[a]	29	46.0
Hearing problems of unknown etiology	15	23.8
Obstructive sleep disorder (obstructive adenoid)	7	11.1
Rhinosinusitis	4	6.3
URI	3	4.8
Hearing screening	3	4.8
Delay speech	2	3.2
Total	63	100.0

[a] URI = upper respiratory tract infection.

Results of otoscopic findings were shown in Table 2. Tympanic membrane characteristics were categorized as color, transparency, mobility, fluid presentation in the middle ear and retraction. Decreased mobility was the most common abnormality of the tympanic membrane found in pneumatic otoscopy (92.1%), followed by retraction. Retraction of the tympanic membrane was found to have significant association with recurrent OME (Chi-square, *p*-value = 0.042).

From the hearing test, only five patients (7.9%) had normal hearing in both ears. Unilateral hearing loss was found in 16 cases (25.4%), bilateral hearing loss was found in 42 cases (66.7%). Mean hearing level of patients with unilateral hearing loss was 27.4 dB and mean hearing level of patients with bilateral hearing loss was 35.2 dB. Mean hearing threshold of patients with unilateral hearing loss was significantly lower than the hearing level of patients with bilateral hearing loss (*p*-value = 0.004). Mean overall hearing level was 31.7 ± 10.3 dB. Mean air-bone gap was 30.9 ± 9.2 dB. Distribution of hearing level was shown in the histogram (Fig. 1). Mean hearing threshold of the patients with fluid bubble seen through the tympanic membrane was significantly lower than those of the patients with effusion without bubble or level in the middle ear (mean ± SD were 27.3 ± 8.2 and 37.4 ± 7.9 dB respectively, *p*-value = 0.001).

Bivariate analysis between mean hearing level and abnormal findings of tympanic membrane characteristics was shown in Table 3. Mean hearing threshold of patients with abnormal transparency (dull tympanic membrane), decreased mobility and retraction of the tympanic membrane were significantly higher that those with normal characteristics. Multiple linear regression analysis of the hearing level was then performed with these three independent variables as shown in Table 4. Collinearity among the three independent variables was checked using variance inflation factor (VIF) which were 1.2, 1.2 and 1.0 respectively, indicating independence among the three variables in multiple linear regression equation.

From multiple linear regression analysis, transparency and retraction were the two independent variables that had significant effect on the hearing level of the patients. The patients with dull or opaque tympanic membrane had a significantly higher hearing threshold of 7.2 dB (*b*) than the patient with translucent ear drum

Table 2
Tympanic membrane findings.

	Normal		Abnormal	
Color	Gray	26 (41.3%)	Other	37 (58.7%)
Transparency	Clear	14 (22.2%)	Dull	49 (77.8%)
Mobility	Normal	5 (7.9%)	Decreased	58 (92.1%)
Fluid	None	12 (19.0%)	Bubble or fluid level	28 (44.4%)
			Full (completely filled)	23 (36.5%)
Retraction	None	21 (33.3%)	Retracted	42 (66.7%)