Diagnostics of Otitis Media With Effusion

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***Abstract — Background*. Chronic Otitis media with effusion (COME) is characterized by presence of effusion in the middle ear behind an intact tympanic membrane during 3 months or more. This study was conducted to evaluate the influence of middle ear effusion on Pneumatic Otoscopy, Otomicroscopy, Impedance Audiometry, Distortion product otoacoustic emission (DPOE) and Brainstem Electrical Response Audiometry (BERA).**

Material and methods. This is a prospective comparative study. Children with COME established on the basis of Otomicroscopy, complete Audiologic examination underwent tympanotomy with collection of effusion from the middle ear. Presence and character liquid were compared with the results of preoperative examinations.

***Results.* We found the substantial inter-tool agreement between tympanotomy and otomicroscopy, impedance audiometry with the detailed analysis, and BERA with hearing thresholds level and latencies I analysis.**

***Conclusion.* Detailed analysis of all characteristics of the electro-acoustical and electro-physiological tests is able to improve our knowledge of ME content what is important for our understanding of the stage of pathological process in the middle ear and for indication of comprehensive management.**

I. INTRODUCTION

Chronic otitis media with effusion (COME) is one of the most common diseases of early childhood. Majority of children - 90% develop some form o otitis media with effusion before school age. OME means the presence of middle-ear effusion (MEE). MEE decreases tympanic-membrane (TM) mobility and impedes the transfer of energy via the middle ear, resulting in hearing losses, commonly between 15 and 40 dB HL. A hearing loss associated with recurrent episodes of OME during critical learning phases can lead to long-term consequences including deficits in language development, auditory processing, binaural hearing, speech perception, sound localization, cognitive ability, and academic success. [1, 2, 3]

Middle ear effusion (MEE) is characterized by the accumulation of fluid in the middle ear. This effusion can be serous, thin or sero-mucous, viscous, or mucous, thick, or, in some cases, purulent, muco-purulent. These characteristics are evident during surgical intervention – myringotomy or tympanotomy.

The information of MEE presence and characteristics is essential for correct treatment.

Myringotomy or tympanotomy is the gold standard for identifying MEE, and, combined with applications of clinical decision theory, can be used to evaluate the performance of noninvasive alternative techniques in predicting of MEE presence.

Pneumatic otoscopy is a method of visualization of tympanic membrane and assessment of it mobility, widely used for diagnostics of OME. Checking of tympanic membrane mobility is recommended as a very important tool for ear examination in pediatric and family doctors practice. [2,3,4,5]

Otomicroscopy has several benefits over pneumatic otoscopy. The higher magnification and brighter light of otomicroscopy allow a more detailed exam of the tympanic membrane and the middle-ear space. The accuracy of otomicroscopy has rarely been evaluated for diagnosing OME. [2]

Both methods – pneumatic otoscopy and otomicroscopy are subjective (depend of quality, experience of specialist and sometimes are problematic in small children without sedation. [3]

The confirmation of OME-diagnostics in early childhood needs objective audiological tests. [2,3,4]

Clinical guidelines of OME management recommends tympanometry 226-Hz or reflectometry additionally to pneumatic otoscopy for diagnostics of OME. Clinical 226-Hz tympanometry, which measures middle-ear admittance across a pressure change in the ear canal, is a reliable and objective measure characterized by good inter-tester agreement. [3, 4, 5, 6]

The measurement of otoacoustic emissions (OAEs) in the patients with MEE showed the markedly decreased otoacoustic emissions on various types of OAEs. In patients with OME, TEOAE and DPOAE can be altered significantly or may even be completely absent. [2, 3, 4,5]

The precision of auditory function in childhood and differentiation of middle ear pathology from hearing loss of other genesis is possible with the Brainstem Electrical Response Audiometry (BERA). [2, 3, 4, 6]

This summary demonstrates that there is a need to improve the current methods ability in characterization of MEE.

II. OBJECTIVES

The primary goal of the present study is to evaluate our methodological complex in predicting MEE and its characteristics in children using tympanotomy as the gold standard.

III. MATERIAL AND METHODS

Subjects.

Children aged 2 to 5 years who visited the Republican Hospital for Children and s howed otoscopic and (or) tympanometric findings of middle ear effusion were included in this study. All patients received medical treatment of nasopharyngeal pathology according to indications. The absence of stable normalization of middle ear function during 3 mo after the treatment was indication for including in the Project. A total number of 68 ears from 34 children corresponded to our were examined by the complex of Audiological assessment (screening tympanogram, DPOAEs, Impedance Audiometry, pure tone audiograms and BERA were performed on each ear a day before tympanotomy and tube placement.

Methods

A pneumatic otoscope (Beta 200 Diagnostic Otoscope; Heine, Germany) with a 3.5 V XHL Halogen illuminator was used. Otomicroscope was also used. The tympanic membrane was evaluated for color, position and mobility. In this study, the appearance of the typical normal tympanic membrane was defined to be translucent, pearl-gray, fully mobile and with no evidence of effusion. OME was diagnosed when one or more of following findings were seen: an opaque tympanic membrane, the TM was yellow or amber color, the TM with decreased mobility, the presence of an air fluid level or bubbles, and a retracted tympanic membrane. [9, 10]

The Impedance audiometer with a probe tone frequency of 226 Hz and a positive and negative pressure sweep between +200 and -400 daPa was used for the tympanogram. The sweep speed was 600 daPa/s except near the tympanogram peak where it slowed to 200 daPa/s, and the compliance range was 0.1–0.6 ml. Three consecutive tests were performed to get a reliable curve for interpretation. The tympanometric curve results were classified according to classification by Jerger in modification by M. Tos [2] as type A, B, C1 and C2. The type A and C curves were interpreted as no middle-ear effusion, and type B was interpreted as a predictive of middle-ear effusion.

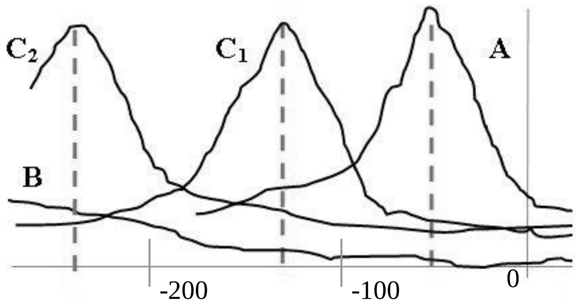

Fig.1. Tympanogram types by Jerger in modification by M. Tos.

Type A: pressure +50 - -99 daPa Type C1: pressure -100 - -199 daPa Type C2: pressure <-200 daPa Type B: pressure no peak of compliance

Because of different shapes of tympanograms registered in one type (Fig.2) we decided to analyze and other characteristics of every curve. [4, 5, 6]

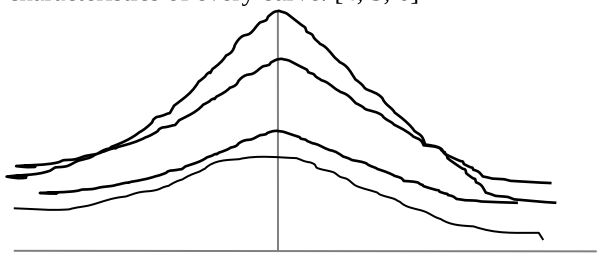

Fig.2. Different shapes of the tympanograms of the same type.

Compliance and absolute gradient as well as relative gradient were calculated according to Brooks (Fig.2).

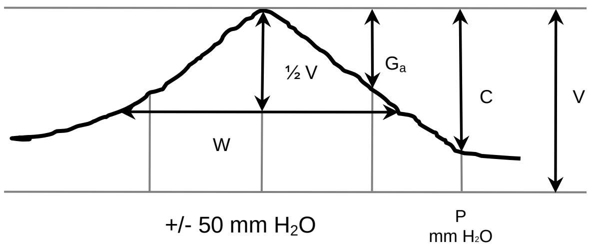

Fig.2. Schema of compliance characteristics calculation.

W – width
V – volum
½ V – ½ volum
C – compliance
Ga – absolute gradient
Gr – relative gradient Gr=C/Ga

OME was suspected if the compliance was less than 0.21 ml, or absolute gradient less than 0.06 ml, or relative gradient less than 0.25. [9, 10, 11, 12]

The presence or absence of an acoustic reflex was tested ipsi laterally at 1000 Hz and 95, 100. 105, 110 dB SPL, using automatic impedance audiometry. Absence of acoustic reflex is suspicious for otitis media.

Brainstem Electrical Response Audiometry. recordings were obtained under commonly used conditions. BERA were recorded from cup electrodes applied at C, A1 and A2 (international 10 - 20 system). Clicks 0.1 ms in duration were presented through TDH - 39 earphone at 7 intensity levels in 10 dB steps (70 - 10dB) until BERA threshold was established. Peak Latencies (I, III, V) and BERA threshold levels were registered; Function Latency-Intensity (V) was analyzed.

The registration of potential electrical activity on 20 dB or more was considered as significant for conductive hearing loss, characteristic for OME.

Additionally, wave PL I prolongation in serial recordings and the shortness of I - V inter-peak latency were checked as an indicator of OME. [10, 12]

DPOAE results were divided into positive and negative.

Collection of effusion was performed in all cases under general anesthesia during surgical intervention which was conducted by the clinical reasons. Surgery was performed using otomicroscope. Collection of fluid was analyzed visually and gradated on 3 grades: 1. no effusion, 2. thin liquid serous or sero-purulent effusion, 3. thick viscous content of tympanic cavity.

The sensitivity and specificity of the 5 diagnostic tools were calculated. Accuracy was calculated as the proportion of true results (both true positives and true negatives) in the study population. The sensitivity and specificity of the four diagnostic tools and the tympanotomy were compared. Inter-tool agreement for the detection of OME was assessed by using kappa-statistics. K values lower than 0.4 meant low agreement, between 0.41 and 0.60 meant moderate agreement, those between 0.61 and 0.80 meant substantial agreement and those between 0.81 and 1.0 meant almost perfect agreement.

IV. RESULTS

The total participants were 34 children (15 boys and 19 girls). The mean patient age was 38.8 months (standard deviation: 13.8 months, range: 24–60 months).

The results of the 5 diagnostic tools in prediction of MEE were compared with that of tympanotomy.

The inter-tool agreement between otomicroscopy and tympanotomy was substantial (kappa = 0.76), pneumatic otoscopy showed moderate agreement with tympanotomy (kappa = 0.51). Tympanogram analysis using classification by Jerger in modification of Tos showed moderate agreement (kappa = 0.45), but after the enlargement of analysis and including of characteristics details it was substantial (kappa = 0.80); even for prediction of thin/thick effusion this agreement was substantial (kappa = 0.68). The inter-tool agreement between reflectometry and tympanotomy was low (kappa less than 0.3, because of low specificity of this method. But its very high sensitivity together with tympanogram results improves the inter-tool agreement between impedance audiometry and tympanotomy to almost perfect (kappa = 0.82). The inter-tool agreement between DPOAE and tympanotomy was moderate (kappa = 0.46), but with the adjustment for the effusion characteristics (thin or thick), it showed better agreement - substantial (kappa = 0.73). The inter-tool agreement between BERA hearing thresholds level and tympanotomy was moderate (kappa = 0.47); the enlargement of analysis and including of latencies I details improved the agreement to substanial one (kappa = 0.76).

V. DISCUSSION

This study surveyed the accuracy of several diagnostic tools, such as pneumatic otoscopy, otomicroscopy, tympanometry, reflectometry, DPOAE and BERA for making the diagnosis of OME in a pediatric population. The specific purpose of this study was to determine the ability of these noninvasive methods to predict presence of effusion and to predict even quality of effusion (thin or thick).

Clinical practice guideline for managing OME developed by 2004 by the Agency for Healthcare Research and Quality with the American Academy of Pediatrics (AAP), the American Academy of Family Physicians and the American Academy of Otolaryngology-Head and Neck Surgery. It was based on evaluating diagnostic studies which compared the ability of different noninvasive methods to diagnose MEE in patients with OME preoperatively. According to this guideline pneumatic otoscopy and tympanometry are the primary diagnostic complex for OME.

Current clinical practice guidelines for treating MEE are based primarily on pneumatic otoscopy, which enables visual inspection of TM mobility in response to pressure changes in a hermetically sealed ear canal. Studies have evaluated the ability of pneumatic otoscopy to predict the presence of MEE as validated by surgical findings at myringotomy. A meta-analysis showed that pneumatic otoscopy was the best of eight methods for diagnosing MEE in children (sensitivity and specificity of 94% and 80%, respectively). Separate studies report sensitivity values from 85% to 91% and specificity from 58% to 89%. Recent analysis demonstrated correlation value = 0.111 between pneumatic otoscopy and myringotomy, which is relatively low. Although pneumatic otoscopy has potential in predicting MEE it is not enough for diagnostics of OME. The procedure needs some conditions, such stillness of the patient during several minutes and his patience on pressure changing in external auditory canal. The interpretation of test results is characterized by subjectivity and depends on quality and experience of specialist. For obvious reasons, myringotomy cannot be used with subjects for whom there are no indications of middle-ear dysfunction, therefore not all cases are controlled by surgery.

We performed pneumatic otoscopy in all patient which were planned for tympanotomy by the analysis of complex examination of middle ear and clinical reasons. The pneumatic otoscopy test was performed in all cases under general anesthesia before surgery, therefore we excluded any anxiety of the child and any inconvenience in achieving of hermetical closure of the external auditory canal by the ear speculum. Even in this conditions the agreement between pneumatic otoscopy and tympanotomy was moderate. Realization of this procedure in early childhood and evaluation of the results by pediatrician or family doctor in everyday practice is questionable.

Otomicroscopy before surgical intervention reveals much more information and we confirm substantial agreement between otomicroscopy and tympanotomy.

Tympanometry is widely used for a clinical purpose to diagnose OME. When compared to tympanotomy, tympanometry predicts MEE with sensitivity from 80% to 90% and specificity from 74% to 100%. This large range of values is the result of differences in the components of the tympanogram across studies that were used to make predictions of MEE. Some authors report a single predictive value of 89% when using flat tympanograms to predict MEE. Using several tympanometric parameters (i.e., gradient, width, peak pressure, and admittance), give possibility for others to conclude, that width is the most accurate predictor of MEE, with a sensitivity and specificity of 81% and 82%, respectively. [2, 4, 6]

We analyzed the ability of all characteristics of the tympanogram in MEE prediction. Our results demonstrated high sensitivity and specificity of the complex – compliance, absolute gradient and relative gradient. The enlargement of analysis and including of characteristics details improved inter-tool agreement from moderate to substantial; even for prediction of thin/thick effusion this agreement was substantial. High sensitivity of reflectometry despite the relatively low specificity together with tympanogram results improves the inter-tool agreement between impedance audiometry and tympanotomy to almost perfect.

Some recent reports about the measurement of otoacoustic emissions (OAEs) in the patients with MEE showed the markedly decreased otoacoustic emissions on various types of OAEs. In patients with serious middle ear disorders, TEOAE and DPOAE can be altered significantly or may even be completely absent. Chronic otitis media with effusion (OME) had no measurable evoked OAEs in 50 % of cases, the type of effusion in the middle ear affected the presence or absence otoemissions. Others demonstrated that MEE resulted in a significant reduction in TEOAEs and mucoid effusion reduced the emissions more than nonmucoid. [2, 4, 6]

In our study the inter-tool agreement between DPOAE and tympanotomy was moderate, but with the adjustment for the effusion characteristics (thin or thick), it showed better agreement – substantial.

Sensitivity and specificity of BAER in detection of OME varies from 79 % to 83 % and 69 % to 72 % respectively. [2, 4] By our opinion, BAER hearing thresholds level are sensitive to thick mucous effusion, but othes characteristics, such as wave PL I prolongation in serial recordings and the shortness of I - V inter-peak latency are sensitive even to thin serous MEE.

VI. CONCLUSION

These preliminary data demonstrate the possibility to precise the diagnostics of OME by noninvasive tools.

Detailed analysis of all characteristics of the electro-acoustical and electro-physiological tests is able to improve our knowledge of ME content what is important for our understanding of the stage of pathological process in the middle ear and for indication of comprehensive treatment.

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