Electro-acoustical and Electrophysiological Examinations in Diagnostics of Otitis Media in Infants

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Abstract
Introduction .Acute Otitis Media is extremely common in infants, often asymptomatic.
Material and methods
Several hundred children in the first year of life were evaluated and treated for a variety of diseases. Seven sets of measures were used in the study: 1. Background characteristics; 2. Otological questionnaires; 3. Otoscopical examination; 4. Impedance audiometry; 5. Brainstem Electrical Response Audiometry; 6. Results of surgery (tympanotomy, antrotomy); 7. Results of Otoscopical examination and Impedance Audiometry in dynamics.
Results This results were compared with cytological and histology examination of surgical findings. High correlation of type A with reducing compliance indexes and proliferation were found. We propose that pathogenesis of otitis media in infants develop in two ways.
Discussion Algorithm of SOM – diagnostics was elaborated. SOM - diagnostics is based on a few steps. The first step is the SOM prognosis in infants. The second step is the otoscopy examination of the infants of the risk group. The third step is the audiometric investigations - impedance audiometry and ABR. Impedance audiometry data are used for information of middle ear pathology character. BERA data give us possibility to estimate the profound of middle ear pathology and degree and character of hearing impairment.
Conclusion We present an algorithm of the management of SOM in infants on the basis of our analysis. This algorithm was also verified in patients from the control group. We were able to correctly-diagnose this disease and prognosticate its course in over 97% of cases.

I. INTRODUCTION

Otitis media in children is one of the oldest problems in pediatric otology. Acute otitis media is the most common disease of early childhood characterized by fever, sleeplessness, irritability, manifestations of intestinal and respiratory disorders. Local changes could be evident or silent what complicates precise diagnostics and sufficient timely treatment, leads to severe complications; impact on hearing, speech and development is significant, long term sequelae such as chronic suppurative otitis media with and without cholesteatoma, retraction pockets, etc, causes disability of child, multiple complications, stipulates long term treatment and surgery. (1, 2, 3)

Undetected and undetectable middle ear pathology occurs in any patient age. But during early infancy there are some special anatomical and functional reasons for SOM development.

Clinical manifestations of SOM include hearing loss as well as wide variations of pain intensity without significant changes of the tympanic membranes. Clinically SOM can be associated with restlessness or sluggishness. This insidious aspect of SOM often makes precise diagnosis difficult.

Additionally antibiotics used to treat infants presenting with gastrointestinal and pulmonary problems can mask associated SOM making diagnosis even more challenging. Therefore potentially lethal middle ear infections may go undetected clinically in pediatric populations (1, 2, 3, 4).

II. OBJECTIVES

This article describes our experience in diagnostics of silent otitis media in infants of the first year of life.

III. MATERIAL AND METHODS

Several hundred children in the first year of life were evaluated and treated for a variety of diseases including intestinal, respiratory tract and neurological disorders. They were evaluated and cared for in the Republic Intensive Care Unit for infants in the Republican Hospital for Children. The most frequent complaint was restlessness or sluggishness.

728 infants (432 males and 296 females) with silent otitis media were examined using special sets of measures. The majority of infants were younger than 6 months (654 - 89 %). Meningitis was observed in 12 % of cases, septicemia in 29 %, pneumonia in 35 %, intestinal disorders in 64 %. For comparison, infants with classical manifestations of middle ear inflammation were included in a second group. A third group, the control group, included infants without middle ear pathology (200 infants, in this category different groups of 50 patients were studied every three months).

IV. METHODS

Seven sets of measures were used in the study: 1. background characteristics; 2. Otological questionnaires; 3. Otological examination; 4. impedance audiometry; 5. Brainstem Electrical Response Audiometry; 6. Results of surgery (tympanotomy, antrotomy); 7. Results of Otological examination and impedance audiometry at 3 and 6 months intervals after diagnosis were documented. (5, 6, 7)

V. BACKGROUND CHARACTERISTICS.

Various background characteristics were recorded for the purpose of identifying risk factors associated with SOM. These included data regarding the following: social-economic status of parents, their age and history of any chronic illnesses. Specifically questions were asked regarding family history of ENT - related diseases;

additionally data was obtained regarding pregnancy, condition of birth, gestation age, weight and Apgar scores at birth; a history was taken regarding nutrition and development of infant during first months before the onset of ear disease; history of respiratory tract infection, intestinal disorders; antibiotic therapy; some information of child behavior and other (52 points).

Otoscopy

These were designed to obtain Otoscopical profile for each child. The "Carl Storz" set was used.

The items covered in each of the examinations included 40 points (color, contour, luster, translucence, light reflex, landmarks and others).

Impedance Audiometry.

An Impedance meter set was used for impedance audiometry. Tympanograms were evaluated according to classification by Jerger, (1970) in modification by M. Tos (5)

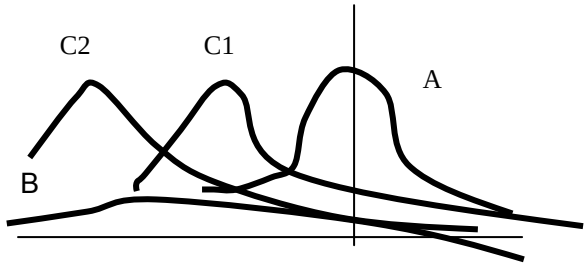

Fig.1. Tympanogram types. Schema.Type A: pressure +50 - -99 mm,Type C_1: pressure -100 - -199 mm H_2O Type C_2: pressure <-200 mm H_2O,Type B: no peak of compliance

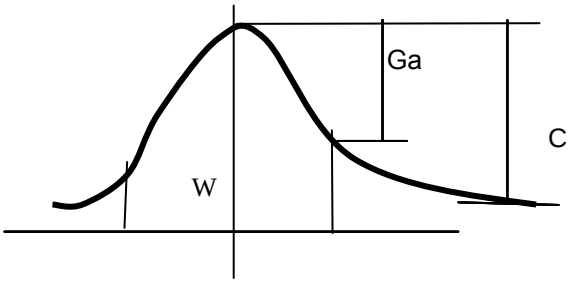

Fig.2. Schema of compliance characteristics calculation. Gr=C/GaW – width C – compliance Ga – absolute gradient Gr – relative gradient

Compliance and absolute gradient as well as relative gradient were calculated according to Brooks (1968).(3, 5).

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 (5).Brainstem Electrical Response Audiometry.

The "Audiostar" ("Madsen Electronics") was used. Recordings were obtained under commonly used conditions. Briefly, ABRs 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 ABR threshold was established. Peak Latencies (I, III, V) and ABR threshold were registered; Function Latency-Intensity (V) was made.(6).

All of these children received medical treatment, 12 % of children underwent surgery – Myringotomy or Myringotomy and Antrotomy.(7)

All patients were followed for at least 1 year.

Statistical analysis (Stjudent-criterium, Fisher-statistics and discriminate analysis) was made.

VI. RESULTS

Some predisposing factors to SOM.

Life histories were analyzed in all 3 groups of patients. Risk factors for SOM development include:

hypotrophy ($p < 0,0001$, $F = 46,3$) inflammatory diseases during first months of life ($p < 0,0001$, $F = 40,2$)antibiotic therapy ($p < 0,0001$, $F = 35,8$)pregnancy complications ($p < 0,0001$, $F = 18,3$)low birth weight ($p < 0,0001$, $F = 9,3$)

Otoscopy

Healthy infants (400 ears) were examined to assess normal tympanic membrane in infants during the first year of life. 104 ears (52 %) had translucency reducing, 64 ears (32 %) had color changes. The *pars tensa* was dull and opaque in 27 % and appeared red in 16 % of ears which were otherwise normal. The *pars flaccida* was thick in 27 % of ears examined. The light reflex was irregular or absent in 49 % of ears. The majority cases of tympanic membrane abnormalities were found in infants younger than 6 months of life. Tympanic membrane changes were observed more often in group of infants, suffering from SOM. Therefore we registered translucency reducing, thickness in majority of cases (98,1 %), light reflex was absent in 95,1 % of ears. Sensitivity of otoscopy in determination of SOM was 98,1 %, but specificity was 48,0 %. We found some important for SOM-diagnostics symptoms. But our opinion is that diagnosis of SOM cannot be established on otomicroscopical findings alone because similar signs can be present in healthy infant's ears. This explains the limitation of otoscopy in this age group.

Impedance audiometry 400 ears of healthy infants were tested. Type A was registered in all cases. Middle ear pressure was in level of + 50 to - 80 mm H2O. Compliance was registered in the range of 0,21 to 0,5 sm3. Absolute gradient was in level of 0,06 to 0,2 sm3, relative gradient was in level of 0,25 to 0,2.Infant with suspected silent inflammation of the middle ear were investigated repeatedly.

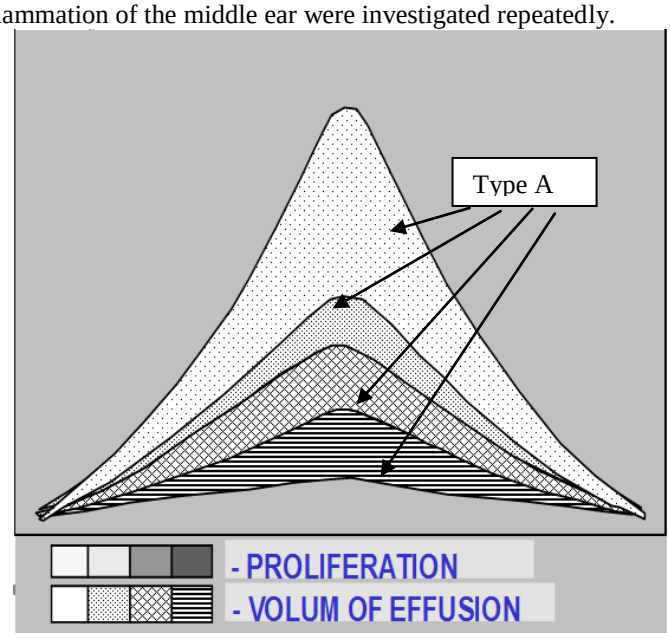

Fig.3. The gradual reducing of compliance indexes in cases of normal middle ear preassure.

Type A was registered in majority of cases (66,2 %), type B - in 30,8 %, type C - in 3 %. Compliance (for types A and C) was in level of 0,1 to 0,3 sm3, in majority of cases (84 %)

less than 0,21 sm3. Absolute gradient was less than 0,06 sm3, relative gradient - less than 0,25.

The gradual reducing of compliance indexes and normal middle ear pressure was found in repeated investigations in SOM-group.

Normal middle ear status, absence of any inflammatory changes correlated with type A of tympanogram. Beginning of pathological process in middle ear cavity provokes development of edema of mucosa, proliferation of granulation tissue without any effusion, what influenced on compliance and its characteristics – absolute and relative gradient. Gradually decreasing compliance in the conditions of open auditory tube does not change the type of tympanogram – it remains type A. (presented on Fig.3). But the height and roundness of the tympanogram are gradually changed till type B, which correlated with big amount of granulations, edema and effusion.

Type B was registered in majority of infants of OOM-group. Type C was found in 17,7 % and type A with reducing of compliance indexes - in 15,2 % of ears. The gradual reducing of middle ear pressure was more characteristic for ears with obvious otitis media.

This results were compared with cytological and histology examination of surgical findings.

High correlation of type A with reducing compliance indexes and proliferation were found. Effusion was correlated with type B.

We propose that pathogenesis of otitis media in infants develop in two ways. (Fig.2)

Fig 2. Two ways of development of otitis media by correlative analysis.

The first way is classical with the basis of dysfunction of the Auditory Tube and vacuum development in middle ear.

The second is the development of otitis media in conditions with open auditory tube. Findings of the impedance audiometry and surgery confirm this hypothesis.

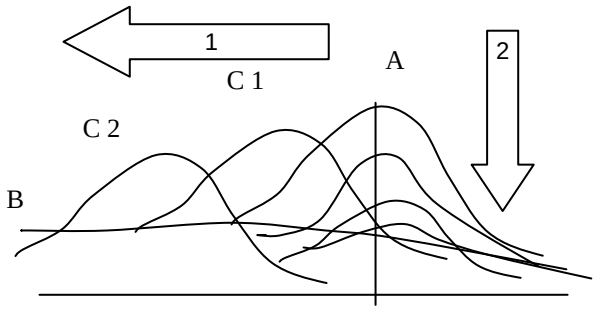

Fig 2. Two ways of development of otitis media.

VII. ABR

Auditory Brainstem Response Indexes were investigated in healthy infants group. Hearing threshold level and peak latency (PL) of wave I were the most constant. Other indexes (PL III, PL V) showed dependence from age, maturity and pathology of neurological system.

We looked at the influence of silent ear inflammation on ABR and found that hearing threshold level depends on presence and degree of pathological processes. We compared the peak latencies in healthy infants and infants with silent otitis media. The difference of PL I was the most statistically reliable. The evidence is already mentioned are the most sensitive and reliable indicators of middle ear pathology. Threshold evaluation was usually minimal. Persistent wave PL I prolongation in serial recordings was the striking ABR findings among infants with abnormal tympanometry. As PL I prolongation was more pronounced than that of wave V, the I - V inter-peak latency was often shorter than expected for age. Latency - Intensity function slope was not grossly altered in these cases.

Algorithm of SOM - diagnostics

SOM - diagnostics is based on a few steps. The first step is the SOM prognosis in infants of the first year of life. Pediatrics in ICU estimates the history data of every child (particular attention is given on the most significant risk factors for SOM - development) and forms the risk group of SOM. The second step is the otoscopy examination of the infants of the risk group. Otology specialist chooses the patients with minimal otoscopic changes and forms the group of infants with suspicion of SOM. The third step is the audiometric investigations - impedance audiometry and ABR. If impedance audiometry changes are observed the BERA is registered. Impedance audiometry data are used for information of middle ear pathology presence and it character. BERA data give us possibility to estimate the profound of middle ear pathology and degree and character of hearing impairment.

VIII. CONCLUSION

We were able to compare the diagnosis and prognostic values of otomicroscopy, pneumatic otoscopy, impedance audiometry, and pure tone audiometry. We present an algorithm of the management of SOM in infants on the basis of our analysis. This algorithm was also verified in patients from the control group. We were able to correctly-diagnose this disease and prognosticate its course in over 97% of cases.

The application of elaborated diagnostic algorithm of SOM significantly improves the results of treatment.

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