

## Evaluation of the Hearing in Children of Mild and Severe Pre-Eclamptic Mothers

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### Abstract

**Aim:** This study is realized with the aim to investigate whether or not there is congenital and progressive hearing loss in the children aged between 1 and 4 whose mothers experienced mild or severe preeclampsia in their pregnancy.

**Material and Methods:** Total 60 children participated in the study whose mothers had mild preeclampsia [20 children] and severe preeclampsia [20 children] and whose mothers were healthy [20 children] for the control group. After the Ear-Nose-Throat [ENT] examination, immittance examination, otoacoustic emission test, Automatic Auditory Brainstem Response [A-ABR] measurement and Free Field [FF] audiometry were applied to the children.

**Result:** As a result of audiological evaluation, Type C tympanogram was observed in the right ear of one child in the group with mild preeclampsia, and in the left ears of total four children in the group with severe preeclampsia [2 children] and in the healthy group [2 children]. No ipsilateral reflex was obtained in the right ears of total two children in the groups with mild [1 child] and severe [1 child] preeclampsia, and in the left ear of one child in the group with severe preeclampsia. One child in the group with mild preeclampsia did not pass from the OAE test. Normal immittance findings and passed result from OAE test were obtained in the second audiological evaluation. All children passed the Automatic Auditory Brainstem Response [A-ABR] test. Hearing thresholds between 125-4000 Hz were obtained in the FF and at 30 dB.

**Conclusion:** When comparison is made between the hearings of children whose mothers were healthy and have experienced preeclampsia; normal hearing findings were obtained for groups, and it is considered that preeclampsia did not cause any congenital and/or progressive hearing loss by it.

**Keywords:** Preeclampsia; Hearing loss; Audiological evaluation

### Introduction

Pre-eclampsia is a syndrome peculiar to pregnancy that occurs after 20th week of pregnancy with multisystem complications. It is responsible for maternal and fetal morbidity and mortality. It is characterized by reduced organ perfusion which is related to vasospasm and endothelial activation. Maternal affects liver, brain, eye, kidney, cardiovascular and nervous system. In pre-eclampsia, the most important state, which is endangering the fetus, occurs in consequence of reduced uteroplacental perfusion [1-3]. Pre-eclampsia, which is hypertensive disease in pregnancy, is the most frequent pregnancy complication and its incidence varies between the regions and the countries. It is seen between 5-10% in all pregnancies [4]. It is diagnosed as severe preeclampsia if the blood pressure is higher than 160/110 mm Hg, and it is diagnosed as mild preeclampsia if the blood pressure is higher than 140/90 mm Hg. Proteinuria is an important symptom and it is described as the edema of the body within the presence of 300 mg or above urinary protein in 24 hours. Edema is not always necessary for clinical diagnosis [5-10]. The first years of life are very important for gaining the language and speaking skills. Not being able to identify the hearing loss in early childhood causes long term negative consequences. So, applying the essential audiological

evaluation for early detection of hearing loss in childhood is highly important. Early detection of hearing loss with early intervention and rehabilitation brings out a better speech, language and social-emotional improvement [11,12]. National neonatal hearing screening program is implemented in our country and it is indicated that hearing loss of neonates is approximately 3/1000 within 1-6/1000 [11]. The rates of hearing loss among the neonates who are in intensive care units can rise up to 10%. Hearing loss of a neonate, who hasn't had hearing screening, can be about 12-30 months. This delay in diagnosis causes an essential loss of time in terms of language and speech development with cognitive, mental and social developments [11,13]. Screening tests are applied with otoacoustic emission [OAE] and Automatic Auditory Brainstem Response [A-ABR]. Otoacoustic emission tests are widely used all around the world. This test has advantages as it can be applied in a simply and rapid way, it does not damage the body and it can determine even the mild hearing loss [12,13]. Because of the function of undeveloped Eustachian tube, middle ear infection is frequently seen among children in the first years of life. Since the treatment affects the development of speech and language, it is important to determine the lasting conductive hearing disorder in this stage. Immittance examination and behavioral hearing tests make contribution to early diagnosis and determining the conductive hearing impairment.

Cross-check tests [cross-check principle], which are not decided according to the only one test result, are highly important in pediatric evaluation. Obtained results are needed to be verified by the other test results. For applying the cross-check strategy successfully, the audiologists conduct according to the child's age, physical condition, developmental level and the level of neuromaturational [14,15]. In audiological emission test battery, there are FF audiometry, visual or conditioned play audiometry, otoacoustic emission tests, tympanometry and acoustic reflex tests, realizing the speech and recognition tests [14,15].

Pre-eclampsia has as well as maternal and also fetal complications. It affects both fetus and the neonate after birth. Hearing loss seen frequently among congenital anomaly prevents the development of child in different aspects. For that reason, the children whose mothers have experienced pre-eclampsia are the population who are needed to be investigated in point of hearing. In this study, it is aimed to evaluate whether or not there is congenital and progressive hearing loss in the children between 1 and 4 whose mothers experienced mild or severe preeclampsia and, if there is hearing loss, its type, its level and its configurations.

## Material and Methods

This study was worked out in Firat University Audiology Units of Ear Nose and Throat Diseases Clinic. Ethical committee approval was received from Firat University Investigation on Humans Ethical Committee. The parents of the children who attended to this study were informed what kind of procedures would be performed and they signed "Informed Patient Voluntarily Approval Form".

## Study Group

20 mild pre-eclamptic mothers, 20 severe pre-eclamptic mothers and 20 healthy mothers for the control group of the children, who were born in Firat University Hospital Clinic of Obstetrics and Gynecology Diseases, participated in the study. For calling the patients, their telephone numbers were gotten from hospital automation system and they were all invited to the study. Nearly 150 families were called, but 40 families accepted the participation for the study. The children, whose mothers were healthy, were chosen among the children who came to clinic for examining. Three groups were created.

**Group A:** the children whose mothers had experienced severe preeclampsia [13 boys, 7 girls]

**Group H:** the children whose mothers experienced mild preeclampsia [10 boys, 10 girls]

**Group S:** the children whose mothers were healthy [11 boys, 9 girls]

For mothers; the mothers who had inflammatory diseases [measles, mumps, rubella, varicella and the other diseases], who had a hereditary hearing loss from their family, who had a consanguineous marriage, who were older than 35, who had systemic disease and who had hypertension before pregnancy were all excluded from the study.

For the children; the children, who had inflammatory diseases before the audiometric evaluation, who had low birth weight [less than 1500 kg], who stayed in intensive care units, who had phototherapy, whose eardrum was not in good condition and who had otitis media with effusion in middle ears [EOM], whose otitis media with effusion could not be treated by medical care, were all excluded from the study. Otosopic examination was performed to all patients in Ear Nose and

Throat Diseases Clinic. After clinical examination and pre-diagnosis, immittance examination in Audiology Unit, TE-OAE test, Free Field [FF] audiometry and A-ABR tests were performed.

As automatic ABR test took long time and as the children were expected to stay calm, some of the conditions could not be fulfilled. The parents did not accept the sedation as they thought that their children had no hearing problems.

## Audiological evaluations

**Immittance measurements:** In immittance measurements, Interacoustics AZ26 and AT235H clinical tympanometry within middle ear pressures at 226 Hz probe tone and 85 dB SPL intensity and acoustic reflections were measured. In automatic evaluation, between +200 daPa and -400 daPa pressures were exerted and tympanogram types of all children were obtained. Ipsilateral acoustic reflection thresholds were evaluated as existence /non-existence.

**Transient-Evoked Otoacoustic Emission [TE-OAE] Measurements:** TEOAE measurements were applied on children with MADSEN Accuscreen emission screening device [83dB SPL] in silent chambers.

**A-ABR measurements:** A-ABR tests were done in silent chambers while the children were calm and while they were lying on a stretcher in a lying position. A-ABR tests were not applied to some children as they had adaptation problems. During the A-ABR test performed by Madsen Accuscreen scanning device, the forehead, the cheek and mastoid bones of antitragus were all cleaned. Single used [disposable] electrodes were placed in this region and it was measured with insert earphones. The device has three electrodes entrance and white-tipped electrodes [active] on the forehead, red-tipped electrodes [passive] on mastoid and black-tipped electrodes [ground] on cheek were placed. Later, each ear was measured separately at 35 dB HL with insert earphones without changing the places of the electrodes. The results of measurements were all gained automatically as passes/failed.

## Free Field Audiometry [FFA]

For the audiological evaluations in FF 'industrial Acoustics Company [IAC]' double cell acoustic isolated rooms were used. Hearing test was performed with the method of Visual Reinforcement Audiometry [VRA] between 125-4000 Hz with the use of Interacoustics Clinical Audiometer AC40 and Spekon Audio speakers. Reliable behavioral responses were equally received. The children were conditioned to the light and sound stimulating's at 70 dB and for each frequency, separate hearing thresholds were found with 10 dB decreasing to 30 dB. SAT values were found within the use of speech lists with live sounds. As speech conditioning, /ba/, /sh/ and /s/ sounds and low, medium and high frequencies were controlled. Speech sounds were given through each two speakers.

## Data Analysis

Statistical analysis was done with SPSS [Statistical Package for Social Sciences] for Windows 12.0 software packet program. While evaluating the study data, descriptive statistical methods [frequencies, rates] and as well as chi-square test for comparing the qualitative data was performed. Meaningfulness was evaluated at a level of  $p < 0.05$ .

## Results

The birth weight of the children varied between 1540 gram and 4130 gram. The birth weight of the children in mild preeclampsia

group was 2600 gram; the birth weight of the children in severe preeclampsia group was 2540 gram. Gestational age of the children participated in the study could vary within 32 and 40 weeks and the average weight in severe preeclampsia group was 36 weeks, the average weight in mild preeclampsia group was 37 weeks. 23 of the mothers who experienced severe and mild preeclampsia had vaginal delivery and 17 of them had caesarean section. The obtained findings are given below as a result of audiologic test applied to the 20 mild pre-eclamptic mothers, 20 severe pre-eclamptic mothers, 20 healthy mothers of the children participated in the study Tympanogram types and ipsilateral reflection findings which were obtained from immitansmetric evaluations are shown in Table 1.

	Patient s Group s H n [%]	Group s A n [%]	Group s S n [%]	P
Right tympanogram				
Type A	20 [%100]	19 [%95.0]	20 [%100]	0.36 2
Type C	1 [%5]	0%	0 [%0]	
Left tympanogram				
Type A	20 [%100]	18 [%90.0]	18 [%90.0]	0.34 3
Type C	0 [%0]	2 [%10.0]	2 [%10.0]	

Right Ipsilateral Acoustic Reflex				
Existence	19 [%95.0]	19 [%95.0]	20 [%100]	0.59 6
Non-existence	1 [%5.0]	1 [%5.0]	0 [%0]	
Right Ipsilateral Acoustic Reflex				
Existence	20 [%100]	19 [%95.0]	20 [%100]	0.36 2
Non-existence	0 [%0]	1 [%5.0]	0 [%0]	
p< 0.05 ; Group H: Mild preeclampsia, Group A:				

**Table 1:** Immitansmetric measurement results according to the groups.

According to the groups, there is no meaningful difference determined statistically between the right and left ear tympanometry measures [p>0.05]. Similarly, there is no meaningful difference determined statistically between the right and left ear ipsilateral acoustic reflex measures [p>0.05].

In the result of the first immitansmetric examination, in the control audiological evaluation of the children, whose Type C tympanogram and ipsilateral acoustic reflex could not be obtained, normal immitansmetric findings were obtained. The results got from the transient evoked otoacoustic emission tests are shown in Table 2.

	Patients groups H n [%]	Groups A n [%]	Groups S n [%]	P
Right TE-OAE				
Passed	19 [%95]	20 [%100]	20 [%100]	0.362
Failed	1 [%5]	0 [%0]	0 [%0]	
Left TE-OAE				
Passed	20 [%100]	20 [%100]	20 [%100]	-
Failed	0 [%0]	0 [%0]	0 [%0]	
p<0.05 Group H: Mild preeclampsia, Group A: Severe preeclampsia, Group S: Healthy children				

**Table 2:** TE-OAE [30dB HL] results according to the groups.

According to the groups, there was no statistically meaningful difference between the results of right ear TE-OAC measurement [p>0.05]. All cases passed from the left ear TE-OAE test measurement. So, no statistical calculation was done. In the first measurement, one child who failed in TE-OAE test could passed the test in the second measurement after medical treatment.

A-ABR test was applied to 35 children. The test could not be applied to 25 children because of the adaptation problem. It was applied to 10 children in group H, 10 children in group A and 15 children in group

S. The children who had the test all passed A-ABR. No statistical calculation was done as all the children in three groups passed A-ABR test.

With the use of warble tone signal in FF for all children, hearing test between 125-4000 Hz were applied in the method of VRA. By placing the speakers' 90 degree angle and 1 meter distance away in a silent chamber, reliable responses at 30 dB signals were received from all the children. In FF measurements, no statistical calculation was done

according to the groups as the hearing thresholds in all groups were determined as 30 dB.

Realizing the speaking with live voice threshold in FF was determined. Reliable results were obtained at 30 dB from all the children with the use of the signals 'ba', 'sh' and 's' sounds. No statistical calculation according to the groups was done as the measurements of realizing the speech in all groups were 30 dB.

## Discussion

The development of the children's language and speech are faster in the first years of life and a 18th months-old child can even make simple sentences. In early babyhood, a child needs to have normal hearing skill for language and speech development. For that reason, not noticing hearing loss in early period, the most frequently seen among congenital anomalies, affects the development of a child in different ways.

In neonatal period, hearing loss of the babies can be identified with the method of objective tests. In our country, national neonatal hearing scanning program is applied and by separating the ill and not ill people between them, the treatment is provided [16]. There has been literature information about auditory of the children whose mothers have preeclampsia. But, a study which deals with all of the audiological findings all together has not been encountered.

In our study, the auditory of 1 and 4 years old children of 20 mild pre-eclamptic, 20 severe pre-eclamptic, 20 healthy mothers was evaluated with immittance examination, TE-OAE, A-ABR and FF audiometry.

In transient evoked otoacoustic emission, while attaining the result 'failed' from the right ear of a child from the group H, all children got the result "passed" in left ear TE-OAE measurement. Type C tympanogram was obtained from the right ear of a child in the group of mild preeclampsia and the left ears of two children in the groups of severe preeclampsia and healthy groups. The result "failed" in otoacoustic emission, Type C tympanogram and the absence of ipsilateral acoustic reflections were attributed to dysfunction of Eustachian and effusion in middle ear. While starting a medical treatment on a child, any other treatments were not administered to the rest of the children. As a consequence of second audiological examination, normal immittance findings on children and the result "passed" from otoacoustic emission were obtained.

For confirming the hearing threshold gotten in FF, speech signals peculiar to frequency [/ba/ with 500 Hz, /sh/ with 2000 Hz, /s/ with 4000 Hz] are used [17]. A harmony was observed between air way hearing thresholds and speech signal peculiar to frequency in FF. These results show that speech signals peculiar to frequency can be used for attesting the air way hearing thresholds on pediatric patients. The specificity of A-ABR is 100% [18]. In our study, 10 mild pre-eclamptic mothers of the children, 10 severe pre-eclamptic mothers of the children and 15 healthy mothers of the children got the result 'passed'. These results show that the nervous systems of the children, whose mothers had preeclampsia, were not affected.

Bakhshae et al. [19] obtained a result 'failed' in TE-OAE measurements from 12 neonates [9 had mild, 3 had severe preeclampsia], in the second measurements, from 3 neonates, when they compared the hearing of neonate of 29 mild pre-eclamptic mothers and 7 severe pre-eclamptic mothers and the hearing of neonates of 114 healthy mothers when they did the third measurement

with ABR, they obtained that all neonates had 'passed' results from hearing tests. According to this, they emphasized that preeclampsia did not cause permanent hearing loss, but it affected the hearing temporarily and more research about this subject was required.

Kisilevsky et al. [20] carried out an auditory evaluation of the fetus of 22 pre-eclamptic and 28 healthy pregnant women. They gave the sound of mother at 95 dB for two minutes with a speaker replaced on mother's stomach and they measured the changes of heart rate. It was observed that when the fetus of healthy pregnant women gave reactions as rising in the heart rate, there were no changes in the heart rate of the fetus of pre-eclamptic pregnant. They attributed this to atypical of auditory process of the fetus of pre-eclamptic pregnant women, the retard of maturation of auditory system and low hearing thresholds or the relief of the hormones.

Kim et al. [21] found in a study about evaluating the hearing of the children of 48 healthy mothers and 24 pre-eclamptic mothers' children who had low birth weight with ABR at 30 dB, they found that the pre-eclamptic mothers' children had shorter V. Wave latencies. It was stated that pre-eclamptic mothers' children's way of auditory brainstem and the maturation of auditory nerve were completed earlier.

Diven et al. [22] showed no hearing loss in their study by evaluating 18 pre-eclamptic mothers' children's hearing with ABR method.

In our study, we evaluated the auditory systems of pre-eclamptic children with A-ABR and all children passed the test. It was thought that the auditory systems of pre-eclamptic children had no problem and they showed normal development with these results. It showed similarity between Diven's [22] studies and Kim et al. [21] studies.

Olusanya et al. [23] worked through possible risk factors caused stillbirth on 3590 neonates and they evaluated the hypertension observed during pregnancy in that group. They indicated that hypertension observed during pregnancy was a risk factor for stillbirth and they faced with triple sensorineural hearing loss of survivor neonates. Although the pathophysiology of preeclampsia was not known, it was indicated that it could cause placental anomaly, bad fetal growing, hypoxia, low birth weight and premature birth. It was stated that these caused sensorineural hearing loss by damaging outer hair cell in cochlea. In this study, it was emphasized that preeclampsia did not harm cochlea and inner ear directly and it caused hearing loss as the reason of different diseases.

Wells [24] asserted that hypertension related with pregnancy [preeclampsia/pregnancy toxemia] caused sensorineural hearing loss on neonates. In order to investigate the hearing loss caused by congenital, he examined 12,927 live births in a 4 year period in England and it was found that only one of 512 pre-eclamptic mothers' children had bilateral sensorineural hearing loss. The twenty-ninth month old neonate died and when its temporal bone was examined histopathologically, they determined that there was bleeding in middle ear and inner ear. In this examination, it was indicated that preeclampsia did not cause sensorineural hearing loss on neonates on its own.

Withagen et al. [25] examined the speech and language problems, motor skills problems, mental retardation formation, hearing loss, vision disorders and educational level of pre-eclamptic mothers' 222 neonates. 29 neonates died in a year and no hearing loss was encountered during the seven year follow-up of the other children who were between 4-12 years old.

Ounsted et al. [26] examined extensively the birth of 236 neonates who were born in approximate date of birth and the birth of 212 neonates who were born in late date than its normal date of birth and they evaluated regularly after four years.

They indicated that preeclampsia and 15 variable factors [bleeding, asphyxia in birth, hypertension, injury, etc.] did not cause auditory, speech and visual disorders.

Ounsted et al. [27], in another study of them, examined that the birth of 224 neonates who were born in approximate date of birth and the birth of 221 neonates who were born in early date of birth and they controlled regularly after four years. In their study, with the regards to preeclampsia and 15 variable factors [hypertension, bleeding at birth, weight of birth, asphyxia, etc.], girls had acute hearing problems, but the boys did not have such kind of problems.

In another study of Ounsted and et. al. [28] they did not observe any hearing loss while comparing 7.5 year old children's auditory of whose 56 mothers' who had preeclampsia over and over with 176 mothers of the children had only hypertension.

Olusanya et al. [23], Wells [24], Withagen et. al. [25], Ounsted et. al. [26-28] showed in their studies that there was no congenital or progressive hearing loss of the children whose mothers were pre-eclamptic.

In our study, it was shown that pre-eclamptic mothers' children, who were between 1-4 years old, had no congenital or progressive hearing loss and similar results were obtained with the other results.

Audiological evaluation on children requires experiments and vast knowledge. Observing the behaviors of children well, understanding their responses to the sound and the communication with the children are so important for obtaining reliable auditory thresholds. No findings of hearing loss were encountered in other studies about the children of pre-eclamptic mothers. In auditory evaluations of pre-eclamptic mothers' children in our study, immittance metric examinations, electrophysiological measurements [TE-OAE, A-ABR] and behavioral tests were applied all together. Obtained results were confirmed with the other test results. Only auditory tests were applied to the children mild or severe pre-eclamptic mothers and it was concluded that there was no congenital or progressive hearing loss with the use of audiological test battery. These results were evaluated in line with literature knowledge.

Our study is outstanding as it is the first study about evaluating auditory of children whose mothers were pre-eclamptic in our country. Auditory was evaluated with the whole systems together and it was shown that preeclampsia did not cause any impairment in its own in auditory system of the children.

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