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Evaluation of Newborn Hearing Screening Results of Aksaray Region

Aksaray Yöresinin Yenidoğan İşitme Taraması Sonuçlarının Değerlendirilmesi

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ABSTRACT Objective: To investigate the possible risk factors that may lead to hearing loss in newborns who failed the hearing screening tests. **Material and Methods:** In this retrospective study, 546 newborns who failed the evoked otoacoustic emission (TEOAE) test or who underwent screening auditory evoked brainstem response (ABR) due to detected risk factors were included between 2010 and 2018. The risk factors of 78 patients who failed the screening ABR test were documented. A total of 468 newborns who passed ABR screening test were evaluated as control group. The data were compared statistically. **Results:** In the comparison of groups who failed and passed the ABR screening test, the mean birth time was found to be significantly earlier (38.1±2.6 and 39.25±1.4 weeks, respectively) (p=0.049), and the mean birth weight was found to be significantly lower (3001 ±628.2 and 3334.82 ±418 g, respectively) (p=0.032) in the failed group. The incidence of neonatal jaundice and jaundice requiring phototherapy was higher in patients who failed the screening ABR test, and this difference was statistically significant (p=0.043 and p=0.028, respectively). The newborns receiving intensive care treatment were also found to be statistically higher (p=0.028). **Conclusion:** The highest risk group for sensorineural hearing loss in newborns may be considered as the ones with low birth weight, early birth time and receiving intensive care treatment.

Keywords: Newborn; hearing loss; hearing tests

ÖZET Amaç: Çalışmamızın amacı uyarılmış oto-kaustik emisyon (TEOAE) testi ve sonrasında işitsel uyarılmış beyin sapı yanıtı (ABR) testinden geçemeyen hastalarda yenidoğanda işitme kaybına yol açabilecek olası risk faktörlerini araştırarak tarama ABR sonuçlarıyla ilişkisini ortaya koymaktır. **Gereç ve Yöntemler:** Çalışmamıza odyoloji birimimizde TEOAE testinden geçemeyen veya risk faktörü bulunduğu için tarama ABR yapılan 546 hasta dâhil edildi. Tarama ABR testinden geçemeyen 78 hastanın risk faktörleri araştırıldı. Elde edilen veriler tarama ABR testinden geçen 468 hastanın verileri ile karşılaştırıldı. **Bulgular:** Gruplar karşılaştırıldığında, tarama ABR testini geçemeyen grubun ortalama doğum zamanı kontrol grubuna göre anlamlı derecede erken (sırasıyla, 38,1±2,6 ve 39,25±1,4 hafta) (p=0,049), ortalama doğum kiloları ise anlamlı derecede düşük bulundu (sırasıyla 3001 ±628.2 ve 3334,82±418 gr.) (p=0,032). Tarama ABR testinden geçemeyen hastalarda neonatal sarılık ve fototerapi gerektiren sarılık görülme oranı yüksek saptandı ve bu fark istatistiksel olarak anlamlıydı (sırasıyla p=0,043 ve p=0,028). Yoğun bakım tedavisi alma oranları da istatistiksel olarak anlamlı derecede yüksek bulundu (p=0,028). **Sonuç:** Yenidoğanlarda sensörinöral işitme kaybı için en riskli grup düşük doğum ağırlığına sahip olanlar, doğum zamanı erken olanlar, yoğun bakım tedavisi alanlar olarak düşünülebilir.

Anahtar Kelimeler: Yenidoğan; işitme kaybı; işitme testleri

Hearing loss is one of the most common diseases among congenital abnormalities. It is observed in approximately 2 to 6 of every 1000 newborns.[1] In 2016, World Health Organization (WHO) estimated that more than 60% of hearing losses in childhood is due to preventable causes. About one third of them are caused by infectious diseases such as meningitis, and one fifth of them are caused by birth complications such as hypoxemia, low birth weight, neonatal hyperbilirubinemia and prematurity.[2]

The electrophysiological based evoked otoacoustic emission (OAE) and auditory brainstem responses (ABR) measurements are commonly used alone or in combination in newborn hearing screening.[3] In recent years, ABR has begun to be used as the first screening test in our country. The diagnosis of hearing loss in an infant who failed the screening program is made around 12-25 months.[4] Since infants who are diagnosed and equipped with a device in the early stage complete their language and speech development, their rehabilitation needs during school periods are minimized.[5] The aim of this study was to present the results of the screening TEOAE test in our province, to examine the factors that may pose a risk for neonatal hearing loss in patients who failed the screening ABR test and to reveal the relationship between these risk factors and screening ABR results.

MATERIAL AND METHODS

This retrospective study was planned in accordance with the World Medical Association Declaration of Helsinki and approval was obtained from the Human Research Ethics Committee of Aksaray University (number: 2019/03-10). A total of 546 patients who failed the TEOAE test and/or were considered to have a risk factor in terms of neonatal hearing loss and and then underwent the screening ABR test between 2010-2018 were included in the study. The infants who passed the TEOAE test for both ears in the first control were considered "passed the screening." Among the infants who came for control, the otoscopic examination and tympanometric evaluation of the infants who failed the unilateral or bilateral TEOAE test were performed. As a result of the examination, the necessary treatments were performed in the presence of a problem such as debris or otitis related to the external auditory canal and/or middle ear that may affect the TEOAE response. After the presence of the problem related to the external auditory canal and middle ear that may affect the TEOAE response was eliminated, the infants were tested again. The infants who failed the TEOAE test in the first control were called for control for the second time to perform the ABR test. The hearing screening of infants was performed using the Accu-screen Pro (Madsen, Denmark) brand otoacoustic emission device. The ABR test is also performed using this device. According to the results of these tests, the patient for whom the outcome 'failed' was obtained for at least one ear was included in the group of patients who failed the screening ABR test while the patient for whom the outcome 'passed' was obtained for both ears was included in the study as a control group. Their records were reviewed, and the risk factors such as birth weeks and weight, whether they received intensive care treatment, whether they had neonatal jaundice, whether they received phototherapy for jaundice, whether there was consanguineous marriage, family history of congenital hearing loss, the presence of facial abnormality, the history of ototoxic drug use and TORCH infection were recorded. Admission to neonatal intensive care unit, neonatal jaundice, jaundice requiring phototherapy, and the use of ototoxic drugs were determined as "yes" or "no" question according to medical data and chart review.

STATISTICAL ANALYSIS

The birth week and birth weight values of the patients were presented as mean+SD (min-max). The ratios of receiving intensive care treatment, having neonatal jaundice, receiving phototherapy, family history of congenital hearing loss, the presence of a facial abnormality, and the use of ototoxic drug were presented as percentage (%). It was determined that birth week and birth weight data did not conform to a normal distribution, using the Kolmogorov-Smirnov test. The Mann-Whitney U test was used to compare the mean birth week and birth weight. The Chi-square test was used to test binary data. All statistical analyses were performed using SPSS 16 for Windows software. A p-value less than 0.05 was considered significant.

RESULTS

In the hearing screening performed in a total of 20192 infants, 14.976 (75%) infants passed the first TEOAE test (Table 1). Among 5216 infants who were called for control for re-evaluation, 4670 (89.5%) infants passed the test while 546 (10.5%) of them failed (Table 2). In the ABR test, bilateral

TABLE 1: Results of TEOAE testing at first performed.

	n (20192)	(100)%
Infants passed the first TEOAE test	14.976	75
Infants failed the first TEOAE test	5216	25
(TEOAE: Transient Evoked Otoacoustic Emission)		

TABLE 2: Results of TEOAE testing in control.

	n (5216)	(100)%
Infants passed the test (TEOAE)	4670	89.5
Infants failed the test (TEOAE)	546	10.5

hearing loss was found in 77 infants while unilateral hearing loss was found in one infant (Table 3).

While the mean birth week of 78 patients who failed the screening ABR test was 38.1 ±2.6 (25-43) weeks, the mean birth week of the control group was 39.25 ±1.4 (29-43) weeks. The birth time was found to be statistically significantly earlier in the patients who failed the ABR test compared to the control group (p=0.032).

While the mean birth weight of the patients who failed the test was 3001 ±628.2 (1430-4150) g, the mean birth weight of the control group was 3334.82 ±418 (2750-3800) g. The birth weights of the patients who failed the screening ABR test were statistically significantly lower compared to the control group (p=0.049).

While 25 (36.23%) out of 78 patients who failed the screening ABR test received treatment in the neonatal intensive care unit, 15 (3.2%) out of 468 patients in the control group were taken into the intensive care unit. The ratio of receiving intensive care treatment was statistically significantly higher in patients who failed the test compared to the control group (p=0.028).

TABLE 3: Results of patients undergoing ABR in the control.

	n (546)	(100)%
Infants passed the test (ABR)	468	85.7
Infants failed the test (ABR)	78	14.3

In patients who failed the screening ABR test, the incidence of neonatal jaundice and the incidence of jaundice requiring phototherapy were high, and this difference was statistically significant (p=0.043 and p=0.013, respectively).

The ratios of a facial abnormality in the infant, the presence of consanguineous marriage, and congenital hearing loss in the family were found to be high in the group who failed the screening ABR test compared to the control group, however, no statistically significant difference was found (p=0.182, p=0.289, p=0.656, respectively). No statistically significant difference was found between the two groups in terms of ototoxic drug use and TORCH infection ratios (p=0.178 and p=0.239, respectively) (Table 4).

TABLE 4: Affecting screening ABR results in newborns.

	Failed the test (ABR) (n=78) number-%	Passed the test (ABR) (n=468) number-%	*p* value
Birth weight,g (median)	3001 ±628.2	3334.82 ±418	**p= 0.032**
Birth week (median)	38.1 ±2.6	39.25 ±1.4	**p= 0.049**
Received treatment in the neonatal intensive care unit	25 (32.05%)	15 (3.20%)	**p= 0.028**
Neonatal jaundice	25 (32.05%)	20 (4.27%)	**p= 0.043**
Jaundice requiring phototherapy	20 (25.64%)	10 (2.13%)	**p= 0.013**
Facial abnormality and skeletal abnormality	3 (3.84%)	1 (0.21%)	p=0.182
Consanguineous marriage	6 (7.69%)	10 (2.13%)	p= 0.289
Congenital hearing loss	7 (8.97%)	5 (1.06%)	p= 0.656
Ototoxic drug use	2 (2.56%)	1 (0.21%)	p= 0.178
TORCH infection	1 (1.28%)	1 (0.21%)	p= 0.239

DISCUSSION

The newborn hearing programs started to be implemented in Turkey in 2004.[6] In European countries, neonatal hearing screenings have been routinely performed since 1998 within the framework of national health policies. The newborn hearing screening program will ensure the early diagnosis of hearing losses which may affect the infant's development and success in the relevant fields. It is reported that the rate of newborn hearing loss in Turkey is 2.2 /1000, and the newborn hearing screening is recommended to be performed in all infants.[6,7]

In our study, TEOAE was performed again for the infants who failed the TEOAE test and came for the first control, and the ABR test was performed for the patients who failed the TEOAE test. There are studies using the ABR test as a routine screening test. However, the fact that the ABR test takes much more time than the TEOAE test, the need for the state of sleep of the infant, and the fact that the test is affected by noisy environments are considered as the negative aspects of the ABR test.[8]

The present study has clinical importance in terms of being a study on regional risk factors along with the TEOAE results. Most of the newborns with congenital hearing loss do not have a risk factor. Thus, hearing screening should be performed not only in newborns with risk factors but also in all newborns. However, the ratio of hearing loss is high in the group at risk. While hearing loss is observed by 0.1% - 0.4% in risk-free newborns, it is expected to be around 10-14% in the group at risk.[9]

There are many factors that may pose risks for newborn hearing losses. Hearing loss may occur in many cases such as a hearing problem in the family, mother's drug use, mother's inflammatory disease history, blood incompatibility, jaundice in the infant, sepsis, meningitis, TORCH infection that may lead to intensive care treatment.[6-9] The limitation of risk factors in our study was related to the small number of patients and inadequacy of medical file records in peripheral hospitals. Some of the risk factors could not be clearly determined due to the inadequacy of medical files.

The relationship found between low birth weight, premature birth time, and ABR test negativity is compatible with the literature data. In the study carried out by Hızlı et al., it was demonstrated that newborn hearing loss risk increased along with the decrease in birth weight.[10] When birth weights are evaluated, it is observed that only 5 infants were 1500 kg and below in our study. The relationship found between birth weight and ARB negativity in our study is compatible with the literature. The fact that birth week is below 36 weeks is also a risk factor for hearing deficiency.[10,11] In our study, we determined that 20 infants were born in week 36 and below.

Liu et al. reported that neonatal jaundice, infections, asphyxia, and low birth weight are the major etiological factors of newborn hearing loss.[11] Hyperbilirubinemia may lead to acute toxicities in the brain and brainstem and may constitute an important risk factor for congenital hearing loss if they are not treated. Most of the permanent hearing losses in the newborn are due to cochlear dysfunction. Hypoxia-ischemia, ototoxic drugs may lead to the loss of hairy cells in the cochlea, and hyperbilirubinemia may lead to hearing loss by causing bilirubin accumulation in the cochlea.[12] In the present study, we found a significant difference related to both neonatal jaundice and jaundice requiring phototherapy between the groups who passed and failed the ABR test, consistenty with the literature.

In this study, no significant relationship was found between consanguineous marriage and ABR negativity. However, in the studies carried out in Asian countries where consanguineous marriage is high, it is reported that there is a positive correlation between hearing loss and consanguineous marriage.[13]

The presence of facial and skeletal abnormalities constitutes a risk factor for newborn hearing loss.[14] In our study, the presence of a facial abnormality and skeletal abnormality in the group who failed the ABR test was higher compared to the

group who passed the ABR test, but it was not statistically significant. This result may be related to the small number of our patients and/or the fact that the bone conduction ABR required to make conductive or mixed type hearing loss diagnosis could not be performed by us.

The presence of congenital hearing loss in the family is also an important risk factor in terms of newborn hearing losses.[15] In the present study, congenital hearing loss was found in the families of 7 patients who failed the ABR test and were in the group at risk. However, this difference was not statistically significant compared to the group without risk.

Congenital infections (TORCH) and ototoxic drug use are also considered as important risk factors for newborn hearing losses.[16] In the current study, 2 patients in the group at risk and one patient in the group without risk had ototoxic drug use. One patient was present in both groups in terms of the TORCH history. However, no statistically significant difference was observed in terms of these risk factors between the groups.

It can be stated that the most important limitations of our study were the small number of patients and the inadequacies in performing the bone conduction ABR test. Furthermore, in this study which was planned as a retrospective study, the inadequacies of anamnesis and medical files in peripheral hospitals were other important limitations in determining risk factors. Therefore, we could not collect the data such as blood levels of bilirubin. Other limitation was that our approach to newborns and infants was providing one hearing screening by using TEOAE and, when necessary, a repeat screening by using ABR. When TEOAE is used as a single screening technology, neural auditory disorders can be unnoticed. Some programs use a combination of screening technologies, TEOAE testing for the initial screening followed by automated ABR for re-screening, to decrease the fail rate.

CONCLUSION

In conclusion, low birth weight, premature birth, receiving postnatal intensive care treatment for various reasons, and jaundice requiring treatment are the most important risk factors associated with ABR results, and it can be said that they pose a high risk for newborn hearing loss. Hearing screening should be performed completely in all newborns regardless of the presence of risk factors.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Serkan Kayabaşı, Fatih Gül;* ***Design:*** *Serkan Kayabaşı, Fatih Gül;* ***Control/Supervision:*** *Fatih Gül;* ***Data Collection and/or Processing:*** *Serkan Kayabaşı, Fatih Gül;* ***Analysis and/or Interpretation:*** *Serkan Kayabaşı, Fatih Gül;* ***Literature Review****: Serkan Kayabaşı, Fatih Gül;* ***Writing the Article:*** *Serkan Kayabaşı;* ***Critical Review****: Fatih Gül;* ***References and Fundings:*** *Serkan Kayabaşı.*

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