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ORIGINAL ARTICLE

Retrospective Evaluation of the Autoacoustic Emission Test and Auditory Brainstem Response in Risky Newborns

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Abstract

Introduction: The early development of the sense of hearing in the baby affects both language and language development considerably, as well as emotional, social and mental development. Hearing loss, which higher in newborns with risk factors, is 1-2% incidence in 1000 live births. Evoked Otoacoustic Emissions (EOAE) and Auditory Brainstem Response (ABR) methods are used in neonatal hearing screenings. We aimed to evaluate the EOAE and ABR results of the newborns in this study and the comparison of the two tests.

Methods: Between January 2011 and July 2011, 104 newborns with a high-risk factor in our hospital were evaluated retrospectively.

Results: The risk factors for the congenital anomaly, be in intensive care and neonatal hyperbilirubinemia, were found to be statistically significantly higher in the Hearing Loss group (+) than in the Hearing Loss group (-). In logistic regression analysis, it was determined that neonatal hyperbilirubinemia was a significant risk factor for hearing loss.

Discussion and Conclusion: Our findings contributed to the national data and our findings suggest that neonatal hyperbilirubinemia increases the risk of hearing loss.

Keywords: Hearing loss; neonatal hyperbilirubinemia; otoacoustic emissions.

Language development and speaking skills in infants develop rapidly, especially in the first months of life. When the baby is six months old, he is more interested in the speech sounds around him than any other sounds. Approximately in eighteen months, the baby begins to form the first simple sentences [1, 2]. Development of the sense of hearing in babies in the early stage significantly affects language and speech development, as well as emotional, social and mental development [3, 4].

The incidence of hearing loss is 1-2 in 1000 live births [5]. This rate is higher in newborns with high-risk factors (as shown in Table 1). The incidence of congenital hypothyroidism is 0.25 and phenylketonuria 0.08 in 1000 live births. Trisomy 21 is seen 1 in 700 live births and cleft palate is seen in 1 in 750 live births. When the incidence of congenital metabolic disease and congenital anomaly are compared with hearing loss, it is unacceptable to skip early diagnosis of hearing loss [6, 7]. Risk factors that may cause hearing loss are summarized below [8].

Two methods are accepted for a neonatal hearing screen-

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Table 1. Neonatal risk factors for hearing loss

- Family history of hereditary sensorineural hearing loss
- Presence of intrauterine infection (TORCH's)
- Craniofacial anomalies
- Birth weight <1500 gr
- Detection of indirect hyperbilirubinemia at the level requiring blood exchange
- Use of ototoxic drugs (aminoglycosides, loop diuretics)
- Previous bacterial meningitis
- Apgar score 1 min: 0-4 or 5 min: 0-6
- Mechanical ventilation requirement for five days or more
- Syndromes associated with sensorineural and/or conductive hearing loss.

ing. These are evoked auto acoustic emissions (EOAE) and auditory brainstem response (ABR) methods. Both methods work automatically, provide results in a short time and do not require invasive procedures [9, 10].

In this study, we planned the EOAE and ABR results of newborns with risk factors to contribute to and evaluate the national data.

Materials and Methods

Otoacoustic emission tests are performed for every newborn in Haydarpasa Numune Training and Research Hospital. The babies are evaluated by a pediatrician before being discharged and the Hearing Screening Information Form stated in the circular published on 31.01.2007 by the General Directorate of Mother and Child Health and Family Planning of the Ministry of Health is completed. Each baby is subjected to a TEOAE test before discharge, and the remaining infants are called for a checkup. ABR test is applied to all babies with risk factors and failed in the TEOAE test. All the tests are performed by experienced audiologists at the ENT Clinic under appropriate conditions.

One hundred four babies with risk factors born in our hospital between January 2011 and July 2011 were evaluated retrospectively. Risk factors were obtained from the Hearing Screening Information Form.

Statistical Analysis

In this study, statistical analysis was performed using NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) package. For data analysis, in addition to descriptive statistical methods (mean, standard deviation), independent t-test was used for comparison of two groups, chi-square test and odds ratio were used for comparison of qualitative data. Logistic regression analysis was used to determine the factors affecting hearing loss. The results were evaluated at $p<0.05$ level of significance.

Results

A total of 104 infants were included in this study. The rate of bilateral failure in TEOAE and ABR was found to be 18%. A statistically significant correlation was observed between the left ABR results and the left TEOAE results and the right ABR results and the right TEOAE results (as shown in Table 2).

The presence of a congenital anomaly in the Hearing Loss (+) group (n=8, 23.5%) was found to be significantly higher than the Hearing Loss (-) group (0%) (p=0.0001). The risk of hearing loss was found to be 45.23 (2.52-81.85) in patients with congenital anomaly compared to those without it (as shown in Table 3).

In the Hearing Loss (+) group, the presence of Staying in the Intensive Care Unit (n=21) (52.9%) was significantly higher than the Hearing Loss (-) group (n=8) (%11.4) (p=0.023). The risk of hearing loss was found to be 2.62 (1.12-6.11) in the presence of Staying in the Intensive Care Unit compared to absence.

The presence of jaundice in the Hearing Loss (+) group (n=11) (32.4%) was significantly higher in than of the Hearing Loss (-) group as (n=8) (11.4%) (p=0.010). The risk of hearing loss was found to be 3.70 (1.33-10.37) in patients with jaundice compared to those without it.

There was no significant difference between the distribution of Hearing Loss (-) and Hearing Loss (+) groups in terms of gender, mode of delivery, birth weight, consanguineous marriage, family history of deafness and APGAR scores.

Table 2. Auditory tests results

	LEFT ABR			
	Hearing loss (-)		Hearing loss (+)	
	n	%	n	%
Left Teoae				
Hearing loss (-)	72	94.70	4	14.30
Hearing loss (+)	4	5.30	24	85.70
Kappa: 0.640 p=0.0001				
	RIGHT ABR			
	Hearing loss (-)		Hearing loss (+)	
	n	%	n	%
Right Teoae				
Hearing loss (-)	64	86.50	6	20
Hearing loss (+)	10	13.50	24	80
Kappa: 0.805 p=0.0001.				

Table 3. Risk factors where hearing test results are significant

Risk factors	Hearing loss (-)		Hearing loss (-)			OR, 95% GA
	n	%	n	%		
Congenital anomaly						
No	70	100	26	76.50	χ^2:17.84	45.23
Yes	0	0.00	8	23.50	p=0.0001	2.52-81.85
ICU admission						
No	49	70	16	47.10	χ^2:5.14	2.62
Yes	21	30	18	52.90	P=0.023	1.12-6.11
Jaundice						
No	62	88.60	23	67.60	χ^2:6.71	3.7
Yes	8	11.40	11	32.40	p=0.010	1.33-10.37

Logistic regression analysis was performed with the variables of congenital anomaly, presence of staying in the intensive care unit, presence of jaundice, all of which affect the hearing loss. In conclusion, the jaundice was determined as a contributing factor (p=0.049).

Discussion

The development of a baby's hearing senses in the early stage significantly affects language and speech development, as well as emotional, social and mental development [3, 4]. If the hearing loss in infants is not recognized in the early stage and appropriate treatment is not administered, speech and language development will be damaged in the future. Hearing loss occurs at a rate of 1-3 per 1000 live births [5, 6]. This rate increases exponentially as risk factors increase.

In a study conducted by Genc et al.[11] at Hacettepe University, the leading institution of the Hearing Screening Program in Turkey, hearing loss was found to be 0.02% in 5485 babies born between 1998-2003. This result is consistent with our general knowledge. In the study, 3-step TEOAE was used. The data obtained show that TEOAE is an easy, rapid and non-invasive method for the assessment of neonatal hearing function. In a study conducted by Ovet et al. on 19.464 newborns born between 2005 and 2008 in Denizli State Hospital, the hearing loss was found to be 0.1%. This result is also consistent with the literature. In the study, TEOAE and ABR were used in two-phase screening test. Similarly, in our study, ABR was applied to the babies who failed from the TEOAE test. In our cases, the rate of failure from the test in risky infants was found to be 15%.

In a study by da Silva et al., [12] the hearing was evaluated using TEOAE and ABR in infants with hyperbilirubinemia. In babies with hyperbilirubinemia, TEOAE and ABR tests showed lower frequencies. The results suggest that hyperbilirubinemia may destroy the cochlear and endocochlear auditory pathways. In our study, a close relationship between the bilirubin elevation and failure from the test was demonstrated. In this respect, both studies support each other.

In a study conducted by Oner et al., [13] 165 infants in Semiha Sakir Maternity and Neonatal Intensive Care Unit were evaluated with TEOAE and ABR for hearing loss. The risk was found to be significantly higher in very low birth weight premature infants. The risk was not found to be high in infants with jaundice requiring blood exchange. It was not possible to establish a causal relationship due to the presence of only one infant requiring blood exchange. Since no such investigation was planned in the methodology of our study, the data obtained did not allow us to compare the above-mentioned study with our study. Since the Neonatal Intensive Care Unit in our hospital provides service at the first level, the number of very low birth weight infants born and treated in our hospital was low. Therefore, we believe that our study does not display that birth weight as a risk factor was a significant parameter.

In a study by Gunizi et al., [14] risk factors for hearing loss were evaluated in mature newborns and hyperbilirubinemia was not found to be a significant risk factor for hearing loss. In our study, hyperbilirubinemia was found to be a significant risk factor. No additional information could be obtained to explain the differences in the results of the studies.

In the study conducted by Pereira et al., [15] newborns with risk factors were evaluated and low birth weight and prematurity were statistically significant. The risk of hearing loss in infants with congenital anomalies has been reported to be 37 times more, and in those with a family history of hearing loss, the risk of hearing loss has been reported to be increased seven times more. In our study, hearing loss

increased in the presence of congenital anomaly, but a family history of hearing loss did not affect risk rating. The main reason for this is the inadequacy of the etiologic history of hearing loss in the family.

In a study performed by Uslu et al., [16] TEOAE was applied to high-risk newborn babies and the rate of failure from the test was reported as 9.5%. In our study, the rate of failure from the test was found to be 18%. This may be due to false-negative (failing) results. Uslu et al. underwent detailed ENT examination and tympanometry for each of the infants had failed in the test, and the test was repeated within one year. In our study, the infants who failed from TEOAE and ABR were referred to tertiary hospitals. Therefore, we do not know the proportion of false-negative results.

Hearing loss in newborns with risk factors is around 10% [17, 18]. This high rate makes it necessary for us, as pediatricians, to know the possible risk factors very well and to evaluate each newborn in detail, in terms of risk factors for hearing loss. The results show that every infant we follow in the Neonatal Intensive Care Unit should have the hearing screening test performed before discharge from the hospital and the ABR test should be used for the babies failed from TEOAE. We have contributed to our national data with our hospital data and we have the opportunity to make comparisons.

As a conclusion of our study, our findings suggest that jaundice increases the risk of hearing loss. Particularly, it was emphasized that the hyperbilirubinemia cases followed up in the first level Neonatal Intensive Care Units must be monitored carefully and hearing screening tests should be performed before the discharge from the hospital.

Ethics Committee Approval: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: Ö.C.; Design: Ç.N., Ö.C.; Data Collection or Processing: F.Y.A., G.A.; Analysis or Interpretation: F.Y.A., G.A.; Literature Search: F.Y.A., G.A.; Writing: F.Y.A.

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References

1. Amin SB, Orlando MS, Dalzell LE, Merle KS, Guillet R. Morphological changes in serial auditory brain stem responses in 24 to 32 weeks' gestational age infants during the first week of life. Ear Hear 1999;20:410–8. [CrossRef]
2. Moore JK, Perazzo LM, Braun A. Time course of axonal myelination in the human brainstem auditory pathway. Hear Res 1995;87:21–31. [CrossRef]
3. Hepper PG, Shahidullah BS. Development of fetal hearing. Arch Dis Child Fetal Neonatal Ed 1994;71:F81–7. [CrossRef]
4. Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early and later-identified children with hearing loss. Pediatrics 1998;102:1161–71. [CrossRef]
5. Su BM, Chan DK. Prevalence of hearing loss in US children and adolescents: findings from NHANES 1988-2010. JAMA Otolaryngol Head Neck Surg 2017;143:920–7. [CrossRef]
6. Kenna MA. Neonatal hearing screening. Pediatr Clin North Am 2003;50:301–13. [CrossRef]
7. Paludetti G, Ottaviani F, Fetoni AR, Zuppa AA, Tortorolo G. Transient evoked Autoacoustic emissions (TEOAEs), in newborns: normative data. Int J Pediatr Otorhinolaryngol 1999;47:235–41. [CrossRef]
8. Joint Committee on Infant Hearing. 1994 Position Statement. Otolaryngol. Head Neck Surg 1995;113:191–6. [CrossRef]
9. Erenberg A, Lemons J, Sia C, Trunkel D, Ziring P. Task force on newborn and infant hearing loss: Detection and intervention. Pediatrics 1999;103:527–30. [CrossRef]
10. American Academy of Pediatrics, Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early detection and intervention programs. Pediatrics 2007;120:898–921. [CrossRef]
11. Genç GA, Başar F, Kayıkçı ME, Türkyılmaz D, Fırat Z, Duran Ö, et al. Hacettepe Üniversitesi Yenidoğan İşitme Taraması Bulguları. Çocuk Sağlığı ve Hastalıkları Dergisi 2005;48:119–24
12. Silva DP, Martins RH. Analysis of transient otoacoustic emissions and brainstem evoked auditory potentials in neonates with hyperbilirubinemia, Braz J Otorhinolaryngol 2009;75381–6. [CrossRef]
13. Öner S. Şiraneci R. Kavuncuoğlu S. Ramoğlu M. Yenidoğan yoğun bakım ünitesinde izlenen riskli yenidoğanların iki basamaklı işitme taraması ile değerlendirilmesi, JOOP Derg 2010;2:35–9.
14. Günizi Z, Genel F, Atlıhan F. Matur yenidoğanlarda sensörinoral işitme kaybı yönünden risk faktörleri ve işitmenin değerlendirilmesinde uyarılmış otoakustik emisyon yöntemi, Çukurova Üniversitesi Tıp Fakültesi Dergisi 2001;26:58–64.
15. Pereira PK, Martins Ade S, Vieira MR, Azevedo MF. Newborn hearing screening program: associatiom between hearing loss and risk factors. Pro Fono 2007;19:267–78. [CrossRef]
16. Uslu C, Taştekin A, Karaşen M, Örs R. Riskli grup yeidoğanlarda transient evoked otoakustik emisyonla işitme taraması sonuçları. Otoskop 2003;2:51–4.
17. 17 Martin WH, Schwegler JW, Gleeson AL, Shi YB. New techniques of hearing asessment. Otolaryngol Clin North Am 1994;27:487–510.
18. Morgan DE, Canalis RF. Auditory screening of infants. Otolaryngol Clin North Am 1991;24:277–84.