Original Article

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Auditory Evaluation of High Risk Newborns by Automated Auditory Brain Stem Response

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Abstract

Objective: The objective of this study was to assess the prevalence of hearing impairment by automated auditory brain stem response (AABR) in newborns admitted to an intensive and intermediate care unit and to analyze the associated risk factors.

Methods: An observational cross-sectional study was conducted between January 2005 and January 2006. 834 newborns (62% boys and 38% girls) were assessed. Newborns had a mean (SD) gestational age of 36 (2.1) weeks with a mean (SD) birth weight of 2950 (1250) grams. The presence of the following neonatal pathologies was investigated: craniofacial malformations, hyperbilirubinemia (total bilirubin $\geq$ 20 mg/dl for all newborns), neonatal asphyxia, congenital infections, septicemia, birth weight ($\leq$1500 g), meningitis, consanguinity, family history of congenital hearing loss and history of convulsion. Newborns who died before the age of 3 months and whose stay in the hospital lasted less than 48 hours were excluded. Chi-square test was used to identify the risk factors for hearing loss.

Findings: Out of 834 neonates, 34 (4.07 %) had sensory-neural hearing loss. The most common risk factors of hearing loss included hyperbilirubinemia (11%), asphyxia (8%), birth weight less than 1500 g (6%), septicemia (6%), convulsion (2%), and meningitis (1%). There was a statistically significant association between hyperbilirubinemia (P=0.001), weight less than 1500 g (P=0.002), cesarean section (P=0.005) and impaired ABR results. There was no relation between family history of congenital hearing loss and craniofacial malformation as risk factors for hearing loss.

Conclusion: This study showed statistically a relation between hyperbilirubinemia, weight less than 1500 g, cesarean section and impaired AABR results. The most common risk factors of hearing loss were hyperbilirubinemia, asphyxia, birth weight less than 1500 g, septicemia, convulsion, and meningitis.

Key Words: Newborn; Hearing screening; Auditory brainstem response; Hearing loss; ABR

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Introduction

Hearing is the means by which the newborn comes into contact with the world of sound and with language structures. It is through oral language that humans are able to make contact with their fellowmen, and develop the ability to share their experiences, thoughts and ideas in the search for new knowledge[1,2]. Hearing loss presents high incidence, affecting around 3 out of every 1,000 live births, and from 2 to 4 out of every 100 newborns leaving the neonatal intensive care unit (NICU)[1,2].The initial signs of hearing loss are very subtle and systematic neonatal hearing screening is the most effective means of early detection. Early diagnosis and immediate intervention are decisive factors in the development and prognosis of these children[3-6].

Because of the high risk of hearing impairment the National Institutes of Health recommend hearing screening of all infants at a NICU before discharge[7,8]. The hearing loss risk indicators, as well as the use of objective methods for performing hearing screening and follow-up were established and reviewed by the Joint Committee on Infant Hearing (JCIH)[9]. There are a few papers studying the association between risk factors and hearing loss in high-risk populations[10-14].

Screening procedures may be divided into two categories: behavioral and electro-physiologic assessments. Behavioral techniques, due to the relative subjectivity of the assessment and difficulty in detecting mild or unilateral losses, determine a high number of false negative results[1]. Electrophysiologic procedures have greater sensitivity and specificity, and the following may be used: auditory brainstem response (ABR), automated auditory brainstem response (AABR) and evoked oto-acoustic emissions (EOAE)[1]. Various studies have analyzed the cost of hearing screening in the neonatal period as well as the difference between the methods available[1]. For hearing screening in the newborns AABR, ABR and OAE test have been used. AABR and OAE can be used alone or, preferably, together. Prior studies have shown the successful use of auditory brainstem response (ABR) hearing screening in the neonatal intensive care setting[7]. The objective of the present study was to assess the prevalence of hearing impairment by ABR in newborns admitted to an intensive and intermediate care unit and to analyze the associated risk factors.

Subjects & Methods

This observational cross-sectional study was conducted between January 2005 and January 2006. The study population of this study consisted of all newborns admitted to the Neonatal Intensive Care Unit (NICU) at Ekbatan and Fatemieh hospitals in Hamadan. The presence of the following neonatal pathologies was investigated: craniofacial malformations, hyperbilirubin-emia (total bilirubin ≥ 20 mg/dl), neonatal asphyxia (defined by the presence of three or more of the following characteristics: Apgar score at 5 minutes <6; umbilical cord blood pH <7.10; hypoxic-ischemic encephalopathy; systemic manfestation), congenital infections, septicemia, birth weight (less than 1500 g), meningitis, family history of congenital hearing loss or consanguinity, and history of convulsion. Newborns who died before the age of 3 months and whose admission lasted for less than 48 hours were excluded. All neonates were referred to an academic audiology center in Hamedan City after receiving appropriate treatment for auditory evaluation by automated auditory brainstem response test (AABR). The test was done with BIOMEDIA AABR. The test was performed in a silent room, reserved for this purpose within the unit, by the researcher, with the child in a state of natural sleep in a common crib. The equipment sends approximately 1,000 clicks at 35 dB by means of phones placed over the newborn ears, and after comparing the response obtained with an internal normal response model, automatically sends the objective pass/fail result, with statistical confidence of 99.96%. The result was considered normal when the newborn

responded to a 35 dB signal bilaterally, and impaired, when it did not present response to 35 dB in at least one ear for two times. Those by whom the AABR test failed, diagnostic tests were done immediately. All parents were informed prior to the ABR hearing screening in their pre-admission packet. Informed consent was taken for all neonates. Data was registered in a central database and analyzed with SPSS version 13.0. We performed chi-square test to identify the contribution of risk factors for hearing loss. P-value <0.05 was considered to be significant. The protocol was assessed and approved by the Research Ethics Committee of the Hamadan University of Medical Sciences.

Findings

834 newborns were assessed (62% boys and 38% girls). All newborns were screened for auditory state by AABR test. Out of 834 neonates evaluated, 34 (4.07 %) had sensory-neural hearing loss. All neonates were evaluated for the association between hyperbilirubinemia and impaired AABR results as well as for birth weight less than 1500g, craniofacial malformation, type of delivery, and family history of hearing loss. In the study population the most common risk factors of hearing loss included hyper-bilirubinemia, asphyxia, birth weight less than 1500g, septicemia, convulsion, and meningitis (table 1). The analysis showed a statistically significant association between hyperbili-rubinemia (*P*=0.001), and impaired AABR results, as well as for weight lower than 1500 g (*P* =0.002) and cesarean section (*P*=0.005). There is no significant interaction between family history of congenital hearing loss (*P*=0.8), and craniofacial malformation as risk factors for hearing loss (*P*=0.4) (table 2).

Table 1- The most common risk factors of hearing loss

Risk Factors	No. (%) (n=34)
Icterus	11 (32.3)
Asphyxia	8 (23.5)
Septicemia	6 (17.6)
Birth weight< 1500g	6 (17.6)
Convulsion	2 (5.9)
Meningitis	1 (2.9)

Table 2- Association between risk factors for hearing loss and impaired ABR results

Risk factors	ABR Result Impaired (n=34)	P- Value
Bilirubin level		
Normal	23 (3%)	0.001
Hyperbilirubinemia	11 (17.5%)	
Birth weight		
Less than 1500g	6 (22.2%)	0.002
1500g and higher	28 (3.5%)	
Type of delivery		
NVD	23 (3.2%)	0.005
Cesarean section	11 (9.2%)	
Craniofacial malformation		
Yes	34 (4%)	0.8
No	-	
Family history of congenital hearing loss		
Yes	-	0.4
No	34 (4.2%)	

Discussion

Hearing loss is apparent in approximately 0.1% of the normal population and is much higher in a defined at-risk population (1–2%) [1,2].Because of the high risk of hearing impairment, hearing screening of all infants before discharge from NICU is recommended[8]. Prior studies have shown the successful use of AABR hearing screening in the neonatal intensive care setting[7].

This observational cross-sectional study was done in order to auditory evaluation of high risk newborns by AABR. The prevalence of hearing loss in the study population was 4.07%. Our findings are in accordance with the study by Lima GML et al[1], who found that the prevalence of hearing impairment in NICU neonates is 4.9%. In a study by Hille et al[7], the overall prevalence of hearing loss is stated to be as 3.2%. Compared to the supposed prevalence of hearing loss in the general population (0.1%)[15,16], this means that being a definite NICU infant in itself already gives a higher risk. Although the data in the literature show variable results, the prevalence of hearing loss in our study was above the average, which may be related to the characteristics of the present group, comprised of newborns admitted to the intensive care unit at a University Hospital that is a regional reference center and therefore provides care to highly complex cases. Thus, a higher prevalence of hearing loss in the population treated at this facility can be expected.

In our study there was a statistical relation between hearing impairment and hyperbilirubinemia, birth weight less than 1500g, and cesarean section, which is in agreement with the results found in the literature[17]. As regards hyperbilirubinemia, the data in the literature point it out as an important cause of deafness[17]. In the study by Lima et al[1], hyperbilirubinemia was not identified as a risk factor. However, when analyzed in conjunction with the other variables, it acquired great statistical power, becoming an important event in the occurrence of hearing impairment. These results suggest that it is necessary to implement protocols with strict control of cases of jaundice, including objective measures for assessing the serum level of bilirubin and highly efficient phototherapy, which represent measures to prevent hearing impairment resulting from hyper-bilirubinemia. The current literature considers weight <1,500 g to be associated with hearing impairment. Although this finding is not consistent and its greater or lesser significance depends on the differences in the populations assessed, as well as the conditions of perinatal care[10,12].

From the multiple analysis, a subset of variables was obtained, which better characterizes the group at risk of hearing impairment; presence of family history, craniofacial malformation, hyper-bilirubinemia, asphyxia, weight less than 1500 g and meningitis, so that these risk factors may direct a systematic assessment, until universal screening becomes possible[17-19]. Brain stem auditory evoked potential monitoring (BAEP) is a neurophysiologic technique that is utilized in the newborn and pediatric age to assess hearing and the integrity of the brain stem auditory pathways[18]. The other study can be performed by Brain stem auditory evoked potential.

Conclusion

This study showed statistically relation between hyperbilirubinemia, weight lower than 1500 g, and cesarean section and impaired AABR results. Also the most common risk factors of hearing loss were hyperbilirubinemia, asphyxia, birth weight less than 1500g, septicemia, convulsion, and meningitis. The prevalence of hearing loss in the study population, using AABR was 4.07%. Therefore, it is essential for all newborns who present isolated or associated risk factors to undergo hearing screening.

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References

1. Lima GML, Marba STM, Santos MF. Hearing screening in a neonatal intensive care unit. J Pediatrie, 2006;82(2):110-4.
2. Lewis DR. As habilidades auditivas do recém-nascido e a triagem auditiva neonatal. In: Andrade CRF. Fonoaudiologia em berçário normal e de risco. São Paulo; Lovise. 1996;Pp:149-68.
3. Downs MP, Yoshinaga- Itano C. The efficacy of early identification and intervention for children with hearing impairment. Pediatr Clin North Am. 1999; 46(1):79-87.
4. Erenberg A, Lemons J, Sia C, et al. Newborn and infant hearing loss: detection and intervention.American Academy of Pediatrics. Task Force on Newborn and Infant Hearing, 1998- 1999. Pediatrics. 1999;103(2):527-30.
5. Kenna MA. Neonatal hearing screening. Pediatr Clin North Am. 2003;50(2):301-13.
6. Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Pediatrics. 2000; 106(3):e43.
7. Hille E, van Straaten HI, Verkerk PH, et al. Prevalence and independent risk factors for hearing loss in NICU infants. Acta Pædiatrica 2007;96(8):1155–8.
8. Marschark M. Consensus on early identification of hearing loss? J Deaf Stud Deaf Educ. 1998;3(2):173-5.
9. Joint Committee on Infant Hearing; American Academy of Audiology; American Academy of Pediatrics; American Speech-Language-Hearing Association; Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Year 2000 position statement: principles and guidelines for early hearing detection and intervention programs. Joint Committee on Infant Hearing, American Academy of Audiology, American Academy of Pediatrics, American Speech-Language-Hearing Association, and Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Pediatrics. 2000; 106(4):798-817.
10. Chu K, Elimian A, Barbera J, et al. Antecedents of newborn hearing loss. Obstet Gynecol. 2003;101(3):584–8.
11. De Capua B, De Felice C, Costantini D, et al. Newborn hearing screening by transient evoked otoacoustic emissions: analysis of response as a function of risk factors. Acta Otorhinolaryngol Ital. 2003;23(1):16–20.
12. Meyer C, Witte J, Hildmann A, et al. Neonatal screening for hearing disorders in infants at risk: incidence, risk factors, and follow-up. Pediatrics. 1999; 104(4 Pt 1):900–4.
13. Suzuki N, Suzumura H. Relation between predischarge auditory brainstem responses and clinical factors in high-risk infants. Pediatr Int. 2004;46(3):255-63.
14. Vohr BR, Widen JE, Cone-Wesson B, et al. Identification of neonatal hearing impairment: characteristics of infants in the neonatal intensive care unit and well-baby nursery. Ear Hear. 2000;21(5):373-82.
15. Davis A, Wood S. The epidemiology of childhood hearing impairment: factor relevant to planning of services. Br J Audiol. 1992;26(2):77-90.
16. Curnock DA. Identifying hearing impairment in infants and young children. BMJ. 1993;307(6914):1225-6.
17. Oysu C, Aslan I, Ulubil A, et al. Incidence of cochlear involvement in hyper-bilirubinemic deafness. Ann Otol Rhinol Laryngol. 2002;111(11):1021-5.
18. Keith H, Chiappa M, Evoked potentials in clinical medicine, 3rd ed. Philadelphia; Lippincott. 1997; Pp:74-87.