Original Article

Investigation of the results of infant hearing screening test with transient evoked otoacoustic emissions in Moradi Hospital of Rafsanjan, Iran, in 2014

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Abstract

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Background: Congenital hearing loss delays many aspects of a child's development, including speech and socio-cognitive development. The aim of this study was determine the results of infant hearing screening with transient evoked otoacoustic emission (TEOAE) in Moradi Hospital, Rafsanjan, Iran: 2014.

Materials and Methods: In this descriptive cross-sectional study from 6017 infants born in Niknafs Hospital in 2014, the hearing of 2743 infants was tested by TEOAE during the first 24 hours after birth. If the result TEOAE test was negative, 3 weeks later, the hearing examination was repeated. If the result of the second examination was negative, a precise hearing examination was performed with auditory brainstem response (ABR) before 3 months of age, and hearing loss cases were identified and referred to competent centers. The obtained information was presented in the form of descriptive statistics.

Results: Of the 2743 infants, 2515 (91.69%) succeeded in the first stage test, 127 (4.63%) in the second stage test, and 16 (0.58%) in the third stage test (ABR test), showing a healthy hearing system. The results of examination with ABR indicated that 4 infants (0.14%) had mild to severe hearing loss who were introduced to specialized centers for cochlear implantation or using hearing aids.

Conclusions: Due to the high accuracy of screening tests, neonatal hearing impairment can be diagnosed and treated in the early days of life. Due to the availability of accurate tests for the examination of the hearing system and their low cost, hearing screening is recommended for infants at birth.

Keywords: Hearing Loss, Infant, Screening, Auditory Brainstem Response, Iran.

Introduction

Hearing has a special role in learning, training, and communication among humans. Desirable hearing performance during the first year after birth is important in the development of language and cognitive performance of the child, as at this stage, neurodevelopment begins and progresses strongly (1).

Hearing impairment is one of the most common congenital defects (1-6 per one thousand infants) (2, 3), which is generally detected very late due to its concealment. Even mild hearing loss can dramatically affect the cognitive, speech, and educational skills of the child and result in severe disability in him/her (4).

Diagnosis of hearing impairment in infants is difficult through common clinical methods. Severe to deep hearing loss in children with a few disabilities may be diagnosed after 30

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months, but the diagnosis of mild to moderate hearing loss may often be postponed until pre-primary school age (5). All infants with different degrees of hearing loss must be diagnosed before the age of 3 months and receive appropriate hearing aids before 6 months of age. Children with severe to deep hearing loss are candidates for cochlear implantation in case of lack of an appropriate response to hearing aids (4).

Moreover, newborn hearing screening is currently being implemented as the most effective means of early detection of this disability in most countries of the world (6). Infant hearing screening using otoacoustic emissions (OAEs), which is a relatively new technology, is very effective in identifying suspected cases of deafness, because OAE is a highly sensitive and specific test. Up to 50% of cases of congenital hearing loss are diagnosed with selective screening of high-risk infants (7). On the other hand, transient evoked otoacoustic emission (TEOAE) is also the best method for hearing screening due to its high precision and ease of use. The sensitivity of this method has been reported between 50-100% in various studies and its specificity as 9-99% (8, 9). Regarding false cases of OAE, auditory brainstem response (ABR) test is used to identify patients with hearing neuropathy in complementary examinations (10). The ABR test is used to accurately assess the nervous system status, especially in cases like the effect of neonatal hyperbilirubinemia on the nervous system (11, 12). Hearing examination using TEOAE in infants is very useful in identifying neonatal hearing loss or deafness.

Of the 10016 infants studied by Ghasemi in Mashhad, Iran, 13 infants (0.13%) had hearing impairment, among which there were 8, 2, and 3 cases of cochlear and bilateral deep hearing loss, moderate cochlear hearing loss, and conductive hearing loss, respectively (7). The frequency of hearing loss in a study by Torkaman in one of Tehran's hospitals was 0.078% (0.78 per 1000 live births) (13). In the study of Zahedpasha, 1.4% of the hospitalized infants had mild to deep unilateral and bilateral hearing impairment. Of these, 2.2% had severe bilateral hearing impairment needing rehabilitation (14). Furthermore, in the study by Amiri, 25 infants with hearing loss were identified among the 25073 infants under study (15). The incidence of hearing loss in a study was reported as 0.2% in Brazil (16) and 0.22 to 3.61 per 1000 live births in the United States (17). Untreated hearing loss in the neonatal period has adverse and irreparable effects on mental development, learning rate (18), social interactions (19), and quality of life (QOL) in an adult (20). Early diagnosis and treatment of this disorder will help the child better identify the environment. Until the present study was conducted in Rafsanjan, Iran, there was no coherent program and an equipped center to examine the hearing of infants. Therefore, after equipping Moradi Educational-Treatment Center with the advanced neonatal hearing screening system, the present study was conducted to determine the results of hearing screening of infants using TEOAE in Moradi Hospital of Rafsanjan in 2014.

Material and Methods

This cross-sectional, descriptive study was conducted using census sampling in Niknafs Hospital in Rafsanjan in 2014. Initially, one of the researchers explained the importance of the topic for the detection of hearing loss and the importance of early treatment in the prevention of future disabilities for the parents of infants. They were assured that hearing screening is a painless and uncomplicated process. After presenting the explanation, of 6017 infants, the parents of 2743 infants (45.59%) completed the informed consent form. They were then asked to transfer their infants to the hearing aid center of Moradi Hospital within the first 24 hours after birth and before discharge. They were assured that their information would remain confidential. Ill infants, those requiring special care, and infants with external ear

canal disorders (atresia and stenosis) were excluded from the study.

Subsequently, the demographic characteristics checklist, which included items like infant's gender and birth rank, and parents' age, was completed by a researcher through interviews. Then, the primary examination and otoscopy of the infants were performed. The external ear canal was wiped of earwax and other wastes and the hearing test was performed with the TEOAE device (AccuScreen, MADSEN, Denmark). In the TEOAE method, a small probe is inserted into the baby's ear canal and in order to scan hearing, the device automatically emits a sound into the baby's ear and processes its reflection. In the case of a healthy sound transmission pathway and the absence of any infection in the middle ear as well as the health of the hearing cochlear system, the TEOAE test result will be PASS. In case of any problem in any of the above sections, the FAIL result is reported (21).

During the test, no pain or unpleasant feeling was created for the baby, and if the baby was sleeping, the test for each ear lasted a maximum of 2 minutes. If the test failed, the baby was be reassessed within the next 3 weeks. If the test failed again, the child's auditory nervous system was evaluated before 3 months of age through ABR testing using the ABR device (Vivosonic Inc., Germany). In the ABR test, the hearing nerve pathways are carefully examined from the cochlea to the brain stem. This test is also simple, uncomplicated, and fast (about 15 minutes for both ears). If an infant did not succeed in the ABR test, he/she was considered as hearing impaired or deaf (13) and referred to specialized centers. Finally, the data were analyzed in SPSS software (version 16, SPSS Inc., Chicago, IL, USA) in the form of descriptive statistics including frequency, mean, and standard deviation. Inferential statistical tests were not performed due to the low number of hearing impaired infants (4 infants).

Results

The mean and standard deviation of the mothers' and fathers' age was 27.28 ± 5.10 and 31.46 ± 5.50 years, respectively, and the level of education of 1394 (50.8%) of the mothers and 1131 (41.2%) of the fathers was diploma. A history of some diseases was investigated among the mothers; 325 (11.8%) and 141 (5.1%) had a history of diabetes and hypertension, respectively. The delivery method of 1434 (52.53%) of infants was natural (Table 1).

Table 1: Demographic indicators of parents of infants born in Niknafs Hospital in Rafsanjan, Iran, in 2014

Variable		Statistical indicator
		Mean ± SD
Age of mother (year)		27.28±5.10
Age of father (year)		31.46±5.50
Variable		N (%)
Mother's education	Under-diploma	773 (28.2)
	Diploma	1394 (50.8)
	Academic degree	576 (21)
Father's education	Under-diploma	1105 (40.3)
	Diploma	1131 (41.2)
	Academic degree	507 (18.5)
Mother's disease history	No history	2259 (82.4)
	Diabetes	325 (11.8)
	Hypertension	141 (5.1)
	Other diseases	65 (0.7)
Natural births	Natural	1434 (53.52)
	Cesarean	1309 (46.48)

Of the 2743 infants under study, 1415 (51.6%) were boys and 1328 (48.4%) were girls. Moreover, 1341 infants (33.54%) were the first child, 920 infants (33.54%) were the second child, 337 infants (12.28%) were the third child, and 145 infants (5.29%) were the fourth to fourteenth children.

In total, 2515 infants (91.69%) successfully passed the first hearing test and 228 infants (8.31%) failed at this stage and were referred to the second stage. Of these, 147 infants (5.36%) were referred for the second stage of hearing test and 81 infants (2.95%) did not refer even with follow up. Of the 147 infants who underwent hearing examination in the second stage, 127 (4.63%) infants passed and 20 (0.73%) entered the third stage, namely the more accurate examination of the hearing system with ABR. All 20 infants who did not pass the second stage referred for ABR at the age of about 3 months. In the ABR test conducted, 16 infants (0.58%) were found to be healthy and 4 infants (0.14%) were found to have mild to severe (unilateral or bilateral) hearing loss (Table 2). These 4 infants were referred to special centers for therapies like cochlear implantation and prescription of hearing aids.

Table 2: Results of hearing screening of infants born in Niknafs Hospital in Rafsanjan, Iran, in 2014

		Frequency	Percentage
Total number of infants screened		2743	100
First stage (TEOAE)	**Pass**	2515	91.96
	Fail	228	8.31
Second stage (TEOAE)	**Pass**	127	4.63
	Fail	20	0.73
Third stage (ABR)	**Pass**	16	0.58
	Fail (Hearing impairment)	4	0.14
Infants not referred		81	2.95

TEOAE: transient evoked otoacoustic emissions; ABR: auditory brainstem response

Discussion

In the present study, of the 6017 infants born in 2014, parents of 2743 (45.59%) infants were satisfied with participating in the study. This rate was 86% in Mashhad (7), 62.9% in Michigan, USA (22), and under 35% in Austria (23). According to the Early Hearing Detection and Intervention (EHDI) program established by the Joint Committee on Infant Hearing (JCIH), a suitable screening program for infants is the one that screens 95% of infants after discharge or within a month of birth and makes a comprehensive attempt to increase this rate to 100% at 6 months from the birth (hospital or maternity ward) (24). It is worth mentioning that infant hearing screening is also carried out by the Welfare Organization in the city of Rafsanjan, and no statistics were available for the authors on the number of infants screened in this organization.

The rate of hearing loss was 0.14% in this study. This rate was 0.7% in Hamadan (25), 0.29% (26), 0.1% (27), and 0.14% (10) in Tehran, 0.12% in Mashhad (7), 0.36% in Dongguan, China (28), 0.11% in Østfold County, Norway (29), and 0.16% in Kerala region of India (30). Differences in the incidence of hearing loss in infants can be due to different reasons, including geographical (31) and genetic differences (18, 32).

The test pass rate was 91.69% in this study. This means that 91.96% of infants successfully passed the first stage of screening. This rate was 96% in the study by Ghasemi (7). According to the JCIH statement, the referral rate for infants' hearing examinations in the screening process must be 4% or less (24). One of the reasons for this issue in the present study was screening of infants' hearing during the first 24 hours after birth. The presence of debris in the external auditory canal and the

presence of fluid in the middle ear impair the hearing of the infant and reduce the pass rate in the first stage of screening. Furthermore, Walsh in 2015 showed that there is a significant difference in the pass rate of infants with an age of less than 24 hours and 24 hours or more (33). The test pass rate was 77.5% in the study of Okhakhu (1) and 91% and 98% in the study by Habib in Saudi Arabia in the first stage and in the second stage, respectively (34). A rate of 99.3% was achieved in the second phase in the present study.

In terms of follow–up in this study, of the 228 infants who did not pass the test in the first stage, 147 (64.47%) referred, which was less than some studies (7) and the minimum of referral cases in the EHDI program. This could be due to the lack of information about the address of the place of residence or change of address. Children lost in this stage are a big problem as they can include half of the cases of hearing loss. Therefore, an accurate follow-up system is necessary in this regard. However, the normal outcome of screening at birth does not signify complete health and hearing screening is necessary in the following years to detect late-onset hearing loss (35). A study showed that, of every 56 infants, an infant may suffer from late-onset hearing loss. The audiometry of these children in the first year of life shows severe hearing impairment (26).

In infant hearing screening process, early and extensive intervention and treatment is of great importance because of the profound effects on the cognitive development of individuals (36). The results of a study by Down, which examined 109 deaf children, showed that infants who were subject to hearing impairment treatments before the age of 6 months had a higher and significant development rate in speech and language tests compared to those who were diagnosed and treated after 6 months of age (37). In the present study, 4 infants with hearing impairment were introduced to the specialized centers, and in subsequent follow-ups, it was found that all of them were treated. The last point is that, according to studies, sensory-neural hearing loss in infants admitted to the neonatal intensive care unit (NICU) is 5 times that of healthy infants (38-40).

In the present study, 45.59% of the total number of infants born within one year were subject to hearing screening in our center. The authors were not informed of the statistics of referral and the number of hearing impairments in other centers like the Welfare Organization. Furthermore, since only healthy infants were screened in the present study, the rate of hearing loss seems to be higher than that obtained in this study. For this reason, all infants admitted to the NICU should be screened for hearing loss. Finally, out of the 228 infants who failed in the first stage of screening, 81 did not refer to the second screening for various reasons. This also affects the rate of hearing impairment. Therefore, it is recommended that such studies be carried out in collaboration with senior and multi-organizational managers and families be obligated to take part in complementary follow-ups and referral in order to better obtain statistics on such health problems.

Conclusion

Infant hearing loss is one of the most common birth disabilities, and due to the high accuracy of screening tests, it can be diagnosed and treated in the early days of the infant's life. Therefore, it is necessary to perform this as a national and enforceable issue in order to prevent future disabilities.

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Conflict of interest: None declared

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