



Assessment of the Prevalence of Hearing Impairment in Neonates Born in Imam Reza, Ghaem and OM-Albanin Hospitals of Mashhad

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ABSTRACT

Introduction: The prevalence of hearing loss in neonates is 2-5 out of every 1,000 live births. Global Health Committee, American Academy of Otolaryngology, and American Academy of Pediatrics have recommended that hearing loss in infants be identified, and treated when possible, prior to 6 months of age. This study was designed with the aim to screen the hearing of neonates in Mashhad, Iran.

Methods: All neonates born in Imam Reza, Om-Albanin and Ghaem Hospitals from November 2008 to November 2010 were screened by Otoacoustic Emission (OAE) test at the time of discharge, followed by a secondary OAE test in case of the failure of the first test; also, a confirmatory Auditory Steady State Response (ASSR) test was performed in 3 weeks to evaluate the type of hearing loss. After data analysis, the frequency of hearing loss in neonates and different risk factors were assessed.

Results: In the present study, 8,987 neonates were analyzed. Thirty one neonates (3.5 per 1000) failed the ASSR test; among these neonates, 6.5%, 25.8%, 25.8% and 19.2% had slight, mild, moderate, and moderate to severe hearing loss, respectively. Also, 16.1% had profound deafness and 6.5% presented with sensorineural involvement. Positive family history of hearing impairments, craniofacial anomalies, hyperbilirubinemia and different hearing syndromes were significantly different between the case and control groups ($P < 0.05$).

Conclusion: In this study, 3.5 neonates out of 1,000 live births had different types of hearing impairments; therefore, it is recommended that screening be performed before discharge.

Keywords: Auditory Steady State Response, Hearing Impairment, Neonates, Otoacoustic Emission, Prevalence

Introduction

The importance of early diagnosis of hearing impairment is quite evident, due to the fact that negligence can result in speech, lingual, cognitive, social and psychological developmental delays. Moreover, to achieve the desired results in habilitation, the patients should be diagnosed in the least amount of time; therefore, recognition of high-risk population is of great significance (1, 2).

The prevalence of hearing loss in neonates is 2-5 out of every 1,000 live births (3). Different International committees including Global Health Committee, American Academy of Otolaryngology, and American Academy of Pediatrics have recommended that hearing loss in infants be identified, and when possible treated, prior to 6 months of age (4). Many studies have demonstrat-

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Table 1. Frequency of neonates in consecutive steps of the study

Participated in the first OAE Test	Failed the First OAE Test	Participated in the second OAE Test	Failed the second OAE Test	Participated in ASSR Test	Failed ASSR
8,987	1,231	1,004	519	516	31
100%	13.69%	11.17%	5.77%	5.74%	0.34%

ed that the chance of treatment in neonates is significantly higher with early diagnosis before the age of 6 months.

Late diagnosis will lead to speech developmental delay (5- 7), and speech difficulty will result in different psychological problems and developmental delay in the child. Studies have revealed that diagnosis and treatment in the first 6 months in children with hearing impairment, particularly bilateral hearing loss, will statistically preserve their language acquisition skills (6, 7). In different studies, the incidence rate of moderate, severe and profound hearing loss is estimated 1-2 in every 1,000 healthy neonates (6-8); 0.1% of live births present with severe to profound hearing loss higher than 70 db (9). Researchers recommend OAE test in 30 weeks of gestation for premature neonates, and the ASSR test is suggested for a more comprehensive evaluation, in case OAE test is positive (10).

Materials and Methods

This prospective and multicentric study was conducted from November 2008 to November 2010 in Mashhad, Iran. The neonates born in 3 university hospitals (Imam Reza, Ghaem and OM-Albanin Hospitals) were studied for hearing impairments at the time of discharge.

As the first step, the patients were all screened with Otoacoustic Emission (OAE) test. In those with positive hearing-loss results in the primary test, the test was repeated after 3 weeks; provided that the same outcomes were achieved, ASSR Test was used to evaluate their hearing loss. Various predisposing factors for hearing impairment were evaluated, which are as follows: hearing loss history of parents, gestational age <37 weeks, APGAR score < 4 at 1st minute, and < 6 at minute 5, intrauterine infections (TORCH), craniofacial anomalies, hyperbilirubinemia with indication for blood exchange transfusion, more than 5-day consumption of aminoglycoside-induced ototoxicity or drug interactions with diuretics, bacterial meningitis, mechanical ventilation > 5 days, and specific syndromes associated with hearing impairments.

To evaluate the aforesaid risk factors, a control group, 2 times bigger than the case group was selected out of healthy neonates and was

compared to the neonates with hearing loss (as the case group). After data analysis, the frequency of hearing impairments and different risk factors were assessed. Frequency tables and diagrams, mean indices and standard deviation were used to describe the data. Data analysis was performed using Chi-square, ANOVA and logistic regression test; P-value less than 0.05 was considered statistically significant.

Results

A total of 8,987 neonates were enrolled in the present study (Table 1). Of all the subjects, 1,231 cases (14%) failed the first OAE test, and 1,004 neonates participated in the secondary OAE test to confirm the former obtained outcomes. After the second OAE test, 519 babies (52%) were referred to the hospital again, and ASSR test was performed on 516 neonates (except for 3 infants). Eventually, hearing impairments of 31 neonates were confirmed as they failed the ASSR test (6% of those who referred for the second OAE test).

A total of 230 participants left the study, 227 neonates before the secondary OAE test and 3 others before the ASSR test. Therefore, the prevalence of hearing impairment among the studied population was approximately 3.5 to 3.8 in 1,000 live births. (With a total number of 8,760 neonates including the 3 neonates who left the study before ASSR test, disregarding the results of the ASSR test)

Among the newborns who failed the ASSR test, 6.5% and 16.1% had slight hearing loss and complete deafness, respectively; 6.5% presented with sensorineural involvement (Table 2).

Table 2. The frequency of neonates with different hearing impairment severities

Severity	Number (percent)
Slight	2 (6.5)
Mild	8 (25.8)
Moderate	8 (25.8)
Moderate to Severe	6 (19.4)
Profound	5 (16.1)
Neuropathy	2 (6.5)
Total	31 (100)

Craniofacial anomalies, hyperbilirubinemia, syndromes associated with hearing impairment and positive family history of hearing impairment were mostly observed in the case group in comparison with the control group (Table 3).

Table 3. The frequency of different risk factors in case and control groups

Risk Factor	Case Group	Control Group	P-value
Mother's Academic Education	25.8%	17.9%	0.54
Mother's Age (Year)	27.43	25	0.091
Mother's Job (Employee)	26.7%	33.9%	0.33
Gestational Age (weeks)	37.5	32.5	0.48
Birth Weight (Grams)	3123.3	3087.6	0.74
Neonate's age (Days)	1.76	1.32	0.49
Neonate's Gender (Male)	48.4%	57.1%	0.287
Parental Consanguinity	50%	58.9%	0.285
Positive Family History	13.3%	0	P < 0.05
Apgar score < 5	0	1	Insufficient data
TORCH	2	2	Insufficient data
Craniofacial Anomalies	20%	0	P < 0.05
Hyperbilirubinemia	13.3%	0	P < 0.05
Syndromes with Hearing Impairment	33.6%	0	P < 0.05

Discussion

The importance of early diagnosis of hearing impairments is quite obvious, due to the fact that negligence in this regard will result in speech, lingual, cognitive, social and psychological developmental delay (1).

The incidence of hearing impairments in infants with risk factors is 10 times higher, and is approximately 2%-5%. In one study in USA, it was demonstrated that infants whose hearing impairment was identified in less than 6 months of age in the screening programs, have the same developmental prognosis as healthy infants (8). In another study in the Netherlands, it was suggested that diagnosis before 3 months and treatment before 6 months will result in a good prognosis (10).

In 1993, the National Foundation for the Deaf and Other Communicative Impairments emphasized on an early diagnosis of hearing impairments in infants less than 3 months of age and optimally before discharge. Consequently, different organizations in developed countries affirmed that the early hearing screening in neonates is the best way for an early diagnosis and habilitation (11).

The known risk factors for hearing impairment are: the increased level of bilirubin, consumption of some drugs and antibiotics, low Apgar score, meningitis, prematurity and low birth weight, long term mechanical ventilation, malformations of the external and middle ear, and viral infections during pregnancy such as Rubella or Cytomegalovirus (CMV); the auditory tests should be performed for infants with the aforementioned risk factors (12).

A cohort study in Norway (from 1967 to 1993) reported the incidence of hearing

impairment 11 in 10,000 cases; weight of four of the cases was less than 1500 gr and 4 (in 10000) weighed more than 4500 gr. In this study, there was no significant relationship between gestational age and hearing impairment; however, there was a meaningful reduction in the incidence of hearing impairments with gaining weight (4). In another study in Saudi Arabia (2002), the incidence of hearing impairments was 14.87% and 9.78% in low birth weight (<2500 gr) neonates and those with birth weight >2500 gr, respectively (11).

In 2001 in Poland, 110 neonates were studied and low birth weight was reported as the major risk factor leading to hearing impairments and deafness (12). Craniofacial abnormalities, birth weight <1500 gr, and a family history of hearing disorders are mentioned as three major risk factors associated with hearing loss in neonates in neonatal intensive care unit (NICU) of Amien University Hospital (13).

In 1999 in a study in USA, the bilateral sensorineural hearing loss in children within the age range of 3-10 years was reported 5.3 in 10,000. In the studied population, 4.1, 3.7, 6.6 and 51 in 10,000 had birth weight \geq 4,000, between 3000 and 3999 gr, between 1500 and 2499 gr, and < 1500 gr, respectively (14).

In 1993, seventy nine children before the age of school were studied in Sophia Hospital; the birth weight of the participants was less than 1500 gr. Of all the subjects, 26%, 13% and 3% had mild, moderate and severe hearing loss, respectively; abnormal tympanometry was observed in 57% of the patients (15). In a study by Ari-Even Roth D *et al*, 346 neonates were assessed. Bilateral sensorineural hearing loss was observed in 0.3% of the patients and 2.7% had conductive hearing loss (16).

OAE and ASSR tests are the most recognized tests for evaluating hearing function. In neonatal wards, OAE test is the most common test due to its efficiency and low price; however, the results are sometimes falsely interpreted as positive or negative. The false result of OAE test is reported about 4% to 10% (17-19). Therefore, ASSR test is used, in case the result of OAE test is suspicious.

In the present study, 31 neonates (0.35%) had a type of hearing impairment; 26 healthy neonates (6.2%) and 5 (5%) NICU patients were enrolled in the study. The severities of hearing impairment were reported as follows: 65% with slight hearing loss, 25.8% with mild hearing loss, 25.8% with moderate hearing impairment and 19.2% with moderate to severe hearing loss. 16.1% and 6.5%

presented with confirmed deafness and neuropathy, respectively.

As to our results, positive family history of hearing impairments, craniofacial anomalies, hyperbilirubinemia and different hearing syndromes seem to be predisposing factors for hearing impairment.

Conclusion

In this study, 3.5 neonates out of 1000 live births presented with different types of hearing loss; therefore, it is recommended that screening be performed before discharging the patients.

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