Comparison of risk factors in newborn hearing screening in a developing country

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The aim of this study is to evaluate the results of the newborn-hearing screening program (NHSP) in our institute, investigate the risk factors and their correlation to congenital hearing loss (CHL). Newborns who admitted to our clinic for NHSP from June 2014 to December 2014 were included in the study. After the test parents were asked to fill a questionnaire about the risk factors of CHL. Test results and referral rate were compared with risk factors. One thousand consecutive babies were included in the study. The overall referral rate was 3.5%. Mechanic ventilation, history of familial CHL and familial consanguinity were found to be significantly related to CHL.In the light of our results we can conclude that getting access to every newborn for hearing screening is mandatory and targeting the risk factors and informing the family about the follow-up period is important for diagnosing the delayed hearing impairment.

Keywords: congenital hearing loss, newborn hearing screening program, risk factors, MB11 Beraphone.

Congenital hearing loss (CHL) is one of the most common congenital defects, with an estimated prevalence of 0.5% [1].The perception of afferent auditory signals is indicated as essential for the development of a healthy central auditory system [2]. Given that a sufficient auditory system is critical for the linguistic and social development of an infant,early diagnosis and intervention of hearing impairment are equallycrucial.In 1993, the National Institutes of Health formulateda neonatal hearing screeningprogram (NHSP) for implementation during the early months of infant life; this initiative was followed by the release of related guidelines[3,4].

The integrity of the acoustic pathway can be measured by auditory brainstem response (ABR) and otoacoustic emission (OAE) tests. Although early reports did not indicate any significant difference in hearing screening with ABR or OAE in children aged 8–12 months, numerous studies showed that thesensitivity of ABR testsis superior to that of OAE tests because ABR screening enables testing for retrocochlear pathologies[5,6]. The MB11 Beraphone® is a relatively new device that is operated similar to a standard ABR device. The advantages presented by the device are that it enables the analysis of auditory response stimuli after click stimulation, generates more intense responses, and eliminates the need for disposable ear couplers. Additionally, results are obtained at a rapid rate; the maximum test time is 180 s, and the device features high sensitivity rates. Previous studies demonstrated the reliability and high sensitivity rates of the MB11 Beraphone®[7,8].

The current work reports results on newborn hearing screening conducted with the MB11 Beraphone®. The screening was carried out in an institute to analyze the associated demographic risk factors that are prevalent in a developing country. This research aims to evaluate the results of NHSP implementation in our institute and investigate related risk factors and their correlation with CHL. The study is also intended toimprove knowledge about risk factors for hearing loss in a different

cultural setting.

Risk factors for CHL

According to the JCIH position statement released in 2007, the risk factors for CHL are as follows [4]:

History of familial congenital sensorineural hearing loss (SNHL)

Presence of intrauterine infection (TORCH symptoms)

Birth weight <1500 g

Craniofacial anomalies

Indirect hyperbilirubinemia requiring blood transfusion

Ototoxic drug exposure

History of bacterial meningitis

APGAR score of 0–4 (1 min) or 0–6 (5 min)

Mechanic ventilation history longer than 5 days

Syndromes related to SNHL

Some demographic risk factors, such as consanguineous marriage(CM), were also investigated.

Material and Methods

Subjects

The research was reviewed for approval by the institutional review board. One thousand newborns who were admitted to our clinic from June 2014 to December 2014 were included in the study. These newborns were referred by either the same hospital or outpatient facility for testing in accordance with NHSP guidelines. Among all study subjects 156 babies were referred from different hospitals and none of these babies had a prior newborn hearing screening test due to technical reasons of the testing devices. Information about risk factors was obtained from parents and medical records. Babies who had external ear canal anomalies were excluded. All the subjects underwent a newborn hearing screening test with an MB11 Beraphone® device, after which the parents were asked to fill in a questionnaire about the risk factors for CHL. The medical records of each baby were also evaluated. Test results and referral rates were then compared with the risk factors.

Hearing screening

As previously stated, hearing screening was carried out with an MB11 Beraphone® device, which is a recently developed technology for examination in accordance with "pass or refer" protocols. Ideal timing for the test is within the same week of birth before discharge, but this may be varied depending on several factors, particularly for outpatients. After physical and otoscopic examination of the patients, a hearing test was performed on both ears. Babies who failed the first test were directed to a second test with the same device 2 weeks later. If the failure was confirmed in the second test, the baby was referred to a tertiary center for further evaluation.

Statistical analysis

Descriptive statistics were obtained from each group, and mean values, standard deviations, medians, and odds ratios were calculated for each risk factor for CHL. Fisher's exact test and a chi-square test were carried out to compare the test results for the groups. SPSS 15.0 for Windows (SPSS Inc., Chicago, USA) was used for all statistical analyses, a p-value of less than 0.05 was considered statistically significant.

Results

The study group consisted of 1000 consecutive babies with a mean age of 27.5 days (range, 0–88 days). This relatively elder age was thought to be a consequence of the late admission of referral babies. The mean birth weight was 3331 g and the mean gestational period was 38.73 weeks. In total, 88.9% (n=889) of the subjects passed the first test. This was the test before discharge as none of the referral babies had a prior test.

Table I. Overall Results of the Newborn Hearing Screening Tests

	Pass	Fail	Referral
1st test	889 (88.9%)	111 (11.1%)	111 (11.1%)
2nd test	76 (68.4%)	35 (31.6%)	35 (31.6%)
Total	965 (96.5%)	35 (3.5%)	35 (3.5%)

Table II. Type of Hearing Loss

	N	%
Unilateral hearing loss	29	82.9
Bilateral hearing loss	6	17.1
Total	35	100

Among the 11.1%(n=111) who failed the first test, 76.5% and 23.5% had unilateral and bilateral CHL, respectively. The second test was performed on the 111 babies who failed the first test; 68.4% (n=76) passed, 31.6% (n=35) of them failed the test and were referred to a tertiary center for further evaluation (Table I). The overall referral rate of the study group was 3.5%. The mean age of the babies in the referred group was 7.1 days. The laterality of CHL in the referred group is summarized in Table II. Among the 965 babies who passed the tests, 161 had risk factors for CHL. The most common risk factors for these babies were mechanic ventilation (n=137) and hyperbilirubinemia (n=39). In total 814 babies did not have any risk factors for the hearing (n=804) and referred babies (n=10). There were no accurate immitancemetry results of all babies in our dataset thus these results were not discussed in this study.

Mechanic ventilation, history of familial congenital SNHL, and CM were significantly related to CHL (Table III). The odds ratios of these risk factors were 2.29, 4.72, and 3.24 consecutively with a confidence interval of 95%. Of the 23 babies with CM, 17 had also history of familial congenital SNHL. There were more subjects who had more than one risk factor but all babies were categorized according to individual risk factors in Table III.

Discussion

Late diagnosis and intervention of CHL may exacerbate speech impairmentand delay language development. Infants for whom screening is delayed may also suffer from underdeveloped social and cognitive abilities. Given that CHL is one the most common congenital defects in infants, the NHSP has become a mandatory screening program for such patients[9]. In 1982, the JCIH proposed the implementation of the NHSP for children who have risk factors for CHL[10]. In 1994, the committee extended the program to all newborns because 50% of children diagnosed with CHL do not exhibit risk factors before screening [11]. The NHSP has been implemented since 2004 in Turkey. Several reports on this issue have also been published since then [12,13]. For example, a review of the results of the national NHSP in Turkey indicates that 2136 of 764, 352 babies nationwide were diagnosed as having CHL in 4 years[14]. Other studies identified low birth weight, CM, and maternal infections during pregnancy as related risk factors for hearing loss [15-17].

Numerous other papers have also discussed the risk factors for CHL. In our study, mechanic ventilation, history of familial congenital SNHL, and CM were significantly associated with CHL. The prevalence of CM in the United States and North European countries is 1%–2%. In Turkey, however, this ratio ranges at 17%–20% a problem that may be explained by the

Table III. Referral Status, Determined in Accordance with Risk Factors

	Total	Referred	*p*
History of familial congenital SNHL	23	4	0.012*
Intrauterine infection	2	0	NS
Low birth weight	4	1	NS
Craniofacial anomalies	0	0	NS
Hyperbilirubinemia	41	2	NS
Ototoxic drug exposure	0	0	NS
Meningitis	0	0	NS
Low APGAR score	7	0	NS
Mechanic ventilation	150	13	0.023*
Syndromes related to SNHL	0	0	NS
Consanguineous marriage	23	12	0.001*

Note: *-statisticallysignificant; NS-nonsignificant; SNHL-Sensorineuralhearingloss

fact that CM is a popular practice in Middle Eastern countries. Approximately 80% of CHL is transmitted autosomal recessively, which is an issue that emphasizes the risk presented by CM[18]. This risk factor is studied in the current research as a demographic determinant given that its effects have been underestimated and disregarded in previous studies. To the best of our knowledge, only Karaca[17] has exhaustively analyzedand found CM to be a significant risk factor for CHL. Accurate information about the risks of CM is critical, especially in countries where CM is prevalent.

Consistent with our results, Bielecki et al[19]. identified mechanic ventilation as a significant risk factor for CHL. Mechanic ventilation causes damage in the peripheral auditory pathway, as indicated in the literature [20]. Low APGAR score, a risk factor also pointed out by Coenraad[21],was a statistically significant factor for CHL in the present research.

The goals of the NHSP are to carry out screening for every newborn child and identify those with hearing impairment. The identification of risk factors during an infant's early life is important, not to enable the selection of babies for testing, but to identify children who may require close follow-up in the future. Because hearing loss may be multifactorial and may be precipitated by other determinants, children who exhibit risk factors may experience hearing impairment after passing a hearing screening test. We therefore recommend a follow-up program for children who have passed screening tests despite exhibiting risk factors for CHL. Such a program is important because of the risk of delayed onset of CHL which in fact is a part of NHSP recommendations in Turkey according to JCIH statements. In our study, the referral rate was 3.5%, a result consistent with the literature[22].

The limitations of this study arethe lack of immitancemetry results and that it does not provide further results on the patients who were referred to tertiary centers. Comparing such results with the findings of this work may provide more data onpatients suffering from CHL.

On an annual basis, more than 665,000 children are born with hearing impairment[20]. Early detection and intervention for children with CHL are critical for the successful development of speech, language, and social skills. To this end, this study implemented NHSP screening for infants admitted into our clinic. Aside from NHSP implementation, other important requirements for the effective diagnosis of delayed hearing impairment are accurately identifying children with risk factors and informing parents about the importance of the follow-up period. Our results indicate that access to hearing screening for newborns should be mandatory.

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