Research Article

Hearing Screening of Infant and Children Suspected of Congenital Hearing Loss at Dustira Cimahi Hospital

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Abstract.

Hearing problems in children impact development, especially speech and language. Some risk factors are known to influence the occurrence of congenital deafness. For the last five years, screening with Otoacoustic Emissions (OAE) and Brainstem Evoked Response Audiometry (BERA) examinations has been used at Dustira Hospital to make a diagnosis and intervene as early as possible. This study aims to obtain the prevalence, risk factors, and OAE and BERA examination results at Dustira Cimahi Hospital. A retrospective descriptive study was conducted on children who underwent the OAE and BERA examination by collecting subject data for the period of January 2020–December 2022. The OAE examination uses distortion product otoacoustic emissions, while the BERA examination is based on the International Standard Organization (ISO). Of the 42 patients who were screened for hearing loss, the 3–5-year-old group was the most dominant (40.4%). Most of the patients were male (66%). While the prenatal risk factor was a history of TORCH infection (12%), the perinatal risk factor was low birth weight (14.2%) and the postnatal risk factor was hyperbilirubinemia (19%). The majority of the OAE examination results were refers found at 32 people (76.1%). The results of the BERA click examination were the presence of wave V found in 38 people (90.4%)). Patients with suspected congenital deafness who underwent hearing screening were in the age range of 3–5 years and were all male. The risk factors found were a history of TORCH infection, low birth weight, and hyperbilirubinemia. The majority of the results of the OAE examination was refer and that of the BERA was wave V.

Keywords: BERA, children, congenital deafness, OAE

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1. Introduction

Hearing plays a very important role for children in learning speech and language, as well as socialization and cognitive development. Children speak based on what they hear so that hearing loss experienced by children from birth will result in speech and language delays. With consequent longer-term risk to educational attainment, mental health, and quality of life. Therefore, hearing loss in neonates must be found immediately to avoid this [1, 2]. Hearing loss in neonates or congenital deafness is the inability to hear that existed since the baby was born. The causes divided based on the prenatal, perinatal, and postnatal period. Joint Committee on Infant Hearing (JCIH) pronounced

that babies who have one or one risk factor will have an increased likelihood of hearing loss. However, it turns out that there are many cases of hearing loss in babies without risk factors. Based on the considerations of JCIH guidelines for the detection and intervention of infants, audiological and clinical evaluation is carried out until the age of 3 months and intervention is carried out before 6 months. A program called Infant Hearing Screening (IHS) has been implemented and developed in order to identify hearing loss in children as early as possible. If hearing loss is detected early, early intervention services can be performed, and prevention of child development delays can be achieved. The IHS program has developed early behavioral observation techniques to screening techniques based on physiological measurements such as otoacoustic emission (OAE) and brainstem response evoke audiometry (BERA) [3-5].

2. Method

This research method is a prospective study by taking data from medical records and interviews with parents of patients undergoing hearing screening at the ENT clinic, Dustira Cimahi Hospital. Data taken in the form of age, sex, risk factors. Then the results of the OAE and BERA examinations were recorded.

3. Results

The study was conducted on patients undergoing OAE and BERA click examinations at Dustira Cimahi Hospital from period January 2020 - December 2022 with a total of 42 patients. Patients who came were referrals from the growth and development pediatric division with complaints of late speech in 36 patients and 6 patient to perform newborn hearing screening. The results of data recording are described below.

3.1. Age characteristics of suspected congenital hearing loss patients at Dustira Cimahi Hospital

Overview of the age characteristics of suspected congenital hearing loss patients at Dustira Cimahi Hospital is shown in Table 1.

The majority of children who carried out hearing screening examinations were aged 3-5 years (40.4%) 1-3 years (26.1%) and less than 1 year with 6 people (14.3%) and aged> 5 years with 8 people (19%).

TABLE 1: Age frequency distribution.

Age	Frequency (n)	Percent (%)
<1 year	6	14.3
1-3 year	11	26.1
>3- 5 year	17	40.4
>5 year	8	19
Total	42	100%

3.2. Gender characteristics of suspected congenital hearing loss patients at Dustira Cimahi Hospital

The sex of the patients who underwent the hearing screening examination is shown in Table 2.

TABLE 2: Sex frequency distribution.

Gender	Frequency (n)	Percent (%)
Male	14	33.3
Female	28	66.7
Total	42	100

The study showed that majority of children who underwent hearing screening were female, with 28 people (66.7%) and 14 male (33.3%).

3.3. Frequency of risk factors of suspected congenital hearing loss patients at Dustira Cimahi Hospital

The risk factors for congenital deafness consist of risk factors during the prenatal, perinatal and postnatal periods. Prenatal risk factors include genetic history, TORCH infection and history of the use of ototoxic drugs. Perinatal risk factors or those during the delivery process, including asphyxia, prematurity and low birth weight (LBW). Postnatal risk factors include hyperbilirubinemia, history of exchange transfusion and history of treatment in the NICU.

The distribution of risk factor frequencies is shown in Table 3.

From the table above, it can be seen that infants who underwent screening had prenatal risk factors (14.2%) in the form of a history of use of ototoxic drugs (2.4%) and TORCH infection (11.9%). Perinatal risk factors were found in 11 people (26%) in the form

Table 3: Frequency distribution of risk factors.

Prenatal	Frequency (n)	Percent (%)
Genetic	0	0
Ototoxic medicine	1	2.4
TORCH infection	5	11.9
Total	6	14.2
Perinatal	Frequency (n)	Percent (%)
Asphyxia	3	7.1
LBW	6	14.3
Prematuritas	2	4.8
Total	11	26
Postnatal	Frequency (n)	Percent (%)
Hyperbilirubinemia	8	19
NICU Carehistory	6	14.3
Exchange Transfusion	0	0
Total	14	33.3

of low birth weight (14.3%) asphyxia (7.1%) and prematurity (4.8%). Postnatal risk factors (33.3%) included hyperbilirubinemia (19%) and NICU care (14.3%).

3.4. Results of Otoacusticc Emmision (OAE) examination of suspected congenital hearing loss patients at Dustira Cimahi Hospital

Otoacoustic Emmision (OAE) examination is performed as an initial screening to check the condition of hair cells in the cochlea. The results of the OAE examination are shown in Table 4.

Table 4: OAE test results.

OAE result	Frequency (n)	Percentt(%)
Pass	10	23.9
Refer	32	76.1
Total	42	100

Based on Table 4, it can be seen that the majority of OAE examination results are refer was found at 32 people (76.1%) and pass found at 10 people (23.9%). The pass results describe hair cells responding to sound stimuli, while the reference results cannot confirm hair cells do not respond to sound and should be followed by BERA examination.

3.5. Results of Brain Evoked Response Audiometry (BERA) examination of suspected congenital hearing loss patients at Dustira Cimahi Hospital

OAE examination is followed by BERA examination to assess auditory function in the auditory system. The results of the BERA examination are shown in Table 5.

Table 5: BERA examination frequency distribution.

BERA Examination	Frequency (n)	Percent (%)
Wave V (+)	38	90.4
Wave V (-)	4	9.5
Total	42	

Based on the Table 5 it can be seen that the majority of BERA test results were the presence of wave V, found at 38 people (90.4.7%) and there is no wave V found at 4 people (9.5%). The absence of V waves describes the absence of a response in the brainstem to a sound stimulus, meaning the child cannot hear at all. The presence of V waves can mean normal or mild to severe hearing loss, and can be corrected with hearing aids or cochlear implants.

4. Discussion

Deafness and hearing loss are widespread and found in every region and country. Today more than 1.5 billion people (nearly 20% of the global population) live with hearing loss. 430 million of them have crippling hearing loss. World Health Organization (WHO) estimate that by 2050, there will be more than 700 million people with disabling hearing loss. Five out of 1000 children are born or have hearing loss during early childhood. Hearing loss is estimated to be the leading cause of disability worldwide. Globally, 34 million children have deafness or hearing loss, of which 60% of cases are caused by preventable causes [6-9].

This study found that the majority of children who carried out hearing screening examinations were in the age range 3-5 years (40%), meanwhile the age <1 year was 6 person (14.2%). The ideal time a baby should undergo hearing screening is before the age of 1 month. Infants who do not pass the neonatal screening should have an audiological examination before 3 months for confirmation. This is because there is an

increased risk of hearing loss in infants with risk factors, and experts recommend these children should undergo a 3-year monitoring period [10].

The results of this study are in accordance with research conducted by Thirunavukarasu et al, 2015 on BERA examination in high-risk children and infants under 10 years, 68% of patients belong to the age group of 1 - 5 years. Similarly, in Thakkar et al's 2018 study on BERA examination in the pediatric age group, 80% of patients belonged to the age group 0-5 years. OAE examination by Gunawan et al, 2016 also found the same thing where almost 91% of children who underwent hearing screening examination were aged < 5 years [11-13].

Language development begins generally during the age of 1 - 3 years. This makes parents most often detect hearing loss or speech delays during this age. Patients most often come to an ENT specialist or audiologist during this age period. In conducting anamnesis or examination of previous patient medical records, most patients have risk factors for hearing loss [12].

Based on gender, the majority of children who carried out hearing screening examinations were females with 28 people (66.7%) and 14 male (33.3%). This result is different with research by Sari et al, 2015 which states that the majority of children who undergo hearing screening examinations are male (65.9%). The same thing was also said by Wiryadi et al, 2019 that more male children come for hearing screening (62%) [14, 15].

Although baby boys more often experience brain maturation disorders, impaired brain white matter development and nerve dysfunction, there is no mechanism that states which gender is prone to hearing loss [16, 17].

Infants who underwent screening had prenatal risk factors (14.2%) in the form of a history of use of ototoxic drugs (2.4%) and TORCH infection (11.9%). Perinatal risk factors were found in 11 people (26%) in the form of low birth weight (14.3%) asphyxia (7.1%) and prematurity (4.8%). Postnatal risk factors (33.3%) included hyperbilirubinemia (19%) and NICU care (14.3%).

Research by Gupta et al, 2019 also found that the majority of risk factors at baby who perform hearing screening is low birth weight (25.2%) and very low birth weight (49.4%). In a study by Rianto et al, 2017 the incidence of SNHL in low weight was also higher than in normal body weight ($p = 0.01$; OR = 3.82; CI 95% = 1.18 - 12.67) thus associated with a higher need for hearing screening. According to Cristobal & Oghalai, impaired hearing function in newborns with low or very low body weight can be caused by resorption of temporal bone mesenchyma and osteoclatic erosion causes premature pneumatization

of temporal bone, resulting in impaired density and air cellsm the mastoid so that this condition causes impaired transmission of acoustic emissions [18-20].

Several other risk factors associated with permanent bilateral congenital hearing loss, including low birth weight < 2500 grams, so hearing screening is needed [12]. Research conducted by Frezza et al, 2019 states that the group of babies at risk of hearing deficit are premature newborns born < 33 weeks of gestational age, especially those admitted to the NICU. Prematurity can cause impaired function of cochlear outer hair cells due to the immaturity of the cochlear organ both anatomically and functionally, so there is a significant difference between the results of OAE examination in neonates aged < 32 weeks compared to full-term. Premature infants are at high risk of hearing loss and their evaluation should be prompt and accurate to ensure activation of early habilitation (within the accepted limits of 4 - 6 months of correction age) that can, in addition, promote maturation of the auditory pathway. However, this category of children requires special caution because common changes in hearing dysfunction are observed. This aspect is very important in the choice and timing of treatment, but also in communication and counseling to the patient's parents [21].

Research conducted by Sari et al, [14] on pediatric patients who underwent hearing examination that the most birth method for these patients was spontaneous (81.9%). Labor with complications such as premature rupture of membranes, large baby size, prolonged labor can increase the risk of perinatal asphyxia leading to impaired oxygenation / hypoxia in the baby. Perinatal asphyxia is a risk factor with a strong association with the occurrence of disorders of hair cells outside the cochlea so it needs special attention immediately [22-23].

Otoacoustic emission (OAE) is a meaningful screening tool in neonatals. The procedure involves inserting a sound probe into the outer ear canal. In the probe there is a microphone and loudspeaker (loudspeaker) that functions to provide sound stimulus. The microphone functions to pick up the sound produced by the cochlea after giving a stimulus. The ear plug is connected to a computer to record the response arising from the cochlea. The inspection should be done in a quiet or soundproof room, this is to reduce environmental noise [4, 24]. The majority of OAE examination results are refer was found at 32 people (76.1%) and pass found at 10 people (23.9%). This is similar with the research of Purnami et al, 2018 where the majority of research subjects were included in the refer category (67.75%). Likewise, the research of Sari et al, that in OAE examination, the majority of the results of the right ear OAE examination were refer (60%) and left ear OAE was also refer (55.1%) [14, 25].

OAE examination is the test that is most often done as a screening because the procedure is easy, safe, and fast. This examination is also easy to interpret, and has a sensitive indication of hearing loss. OAE also does not require special human skills [26].

Brainstem Evoked Response Auditory (BERA) is an electrophysiological recording of responses derived from auditory tissue activation to sound stimuli, starting from the cochlea to along the brainstem, aiming to assess the integrity of nerve synchronization. This examination is non-invasive and has a fairly high objective value [5, 26]. The principle of the BERA examination is to assess changes in electrical potential in the brain after the administration of sound stimuli. Sound stimuli given through the head phone or insert probe will travel through the cochlea (wave I), cochlear nucleus (wave II), superior olivarious nucleus (wave III), lateral lemnicus (IV wave), inferior colliculus (V wave) then go to the auditory cortex in the temporal lobe of the brain [27].

The majority of BERA test results V waves found at 38 people (90.4%) and there were no V waves found at 4 people (9.52%). According to research by Wiryadi et al, [28] the majority of children in hearing screening with the most BERA examination results are the presence of V waves (57.6 - 60.8%). The presence of V waves illustrates no response in the brainstem to a sound stimulus. The presence of V waves illustrates that the brainstem response is still present, even though the patient is clinically normal, or has mild to severe hearing loss. This is a consideration in carrying out hearing rehabilitation with hearing aids or cochlear implants.

V wave is the most stable wave, easy to assess even to the point of a low-intensity and clinically meaningful sound stimulus, therefore the assessment of the predominant BERA potential is based on the latent period (time interval between stimulus onset and wave peak) absolute peak [29].

In this study,10 people with OAE pass results and 4 people who did not find wave V on the BERA examination. OAE describes the response of hair cells in the cochlea, while V waves in BERA describe the brainstem response to sound stimuli. This study is similar to the study of Mirajkar et al, [30] where in 15 children obtained 11 children with bilateral OAE refer results who had normal BERA results, while 4 other children had abnormal BERA results. Johnson et al, [31] also obtained similar results where in 21 children with OAE refer results also had normal BERA results. The results of unilateral OAE refer and BERA refer are not always associated with nerve deafness but can also be caused by disorders of the middle ear. In a study conducted by Chang et al, [32] found 12 children

with unilateral OAE refer results with abnormal BERA results. One child with conductive deafness, 10 children with sensorineural deafness, and 1 child with mixed deafness.

The difference in results between OAE and BERA can be because OAE reflects problems in the cochlea, while BERA reflects problems in the auditory nerve. That is, it could be a case of referring to OAE when there is only a problem in the cochlea but there is no problem with the auditory nerve so that the test results still detect a V wave in BERA [25]. What happens in this study is that the results of OAE refer and the results of BERA pass can be due to middle ear disorders that are not eliminated during the examination so that the OAE results are not accurate, hence the need for tympanometric examination before the examination is carried out. Another possibility is the presence of auditory neuropathy. Auditory neuropathy is a condition in which the function of hair cells is abnormal, while the function of the auditory nerve is impaired. Therefore, on examination, normal OAE and abnormal BERA results will be found [33].

5. Conclusion

Patients with suspected congenital deafness who perform hearing screening are in the age range of 3-5 years, male sex, the risk factors found are history of TORCH infection, low birth weight and hyperbilirubinemia. The majority of the results of the OAE examination was refer and BERA examination was found wave . Hearing screening in children needs to be done as early as possible considering the number of hearing loss is still common at the age of speech development.

Conflict of Interest

There is no conflict of interest in the writing of this paper

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