

When should automatic auditory brainstem response test be used for newborn hearing screening?



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ABSTRACT

Objectives: The aim of this study was to investigate the referral rate and when automatic Auditory Brainstem Response (aABR) should be used for newborn hearing screening.

Methods: The present study enrolled 2933 healthy full-term infants and 176 infants with perinatal risk factors. Hearing screening using Transient Evoked Otoacoustic Emissions (TEOAEs) was performed in newborns for the first time 5 days after birth except perinatal risk factors infants. The TEOAE was repeated to neonates failing to pass at the 15th day after birth. Neonates failing to pass the second TEOAE, repeated the test again at the 30th day after birth. Neonates failing to pass the third TEOAE were referred for the second stage screening using aABR. In addition, neonates with risk factors were tested with aABR directly.

Results: In this research, 85 (2.9%) infants who could not pass the TEOAE and 176 infants exposed to perinatal risk factors, underwent the aABR test. In the aABR, 14 (7.9%) of 176 infants exposed to perinatal risk factors and 10 (11.7%) of 85 infants who could not pass the TEOAE failed to pass. As a result, hearing loss was detected in only 10 (0.34%) of 2933 healthy full-term infants.

Conclusion: TEOAE should be performed at least twice in healthy full-term infants before aABR, because aABR is to be performed by specially trained personnel and takes a long time. In view of these results, it is our opinion that infants without perinatal risk factors should undergo TEOAE screening test and infants who did not pass control screening tests and have perinatal risk factors should absolutely undergo aABR test. But it should be remembered that TEOAE can cause a problem to miss auditory neuropathy in infants without perinatal risk factors.

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1. Introduction

In many studies, hearing loss is a common congenital anomaly, occurring in 1–3 cases per 1000 newborn infants in the healthy infant population while in those, with perinatal risk factors, this value could increase 10–50 times [1].

Perinatal risk factors include prematurity, hyperbilirubinemia, cranio-facial abnormalities, prenatal infections, a family history of hearing loss, culture-positive sepsis, hypoxia and intracranial hemorrhage [1–3]. Preterm infant is one of the most important events in perinatology. An estimated 9.6% of all births are premature [4]. High risk infants include newborn in the neonatal intensive care unit, because research data have demonstrated

that this population is at the highest risk of having neural hearing loss [1].

Position Statement from the Joint Committee on Infant Hearing confirmed that neonates who are in Intensive Care Units for more than 5 days or who have risk factors and a shorter stay should undergo hearing screening with Transient Evoked Otoacoustic Emissions (TEOAEs) and automatic Auditory Brainstem Response (aABR) testing. Those infants are recommended for screening because of the increased occurrence of neural hearing loss in this population, compared with well infants [1]. In fact, TEOAE is used as a screening test as a policy of the national ministry of health and aABR is reserved only for high risk babies and ones who could not pass TEOAE in our country. Because aABR requires more time to perform and experienced personnel and it increases the cost of screening tests.

Infant hearing screening program and early diagnosis for permanent childhood hearing loss have demonstrated that hearing loss adversely affects speech and language progress as well as academic success and social-emotional development [5–9]. Hearing

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impairment may affect the auditory neuropathway of children at a later developmental stage if suitable and optimal interventions are not made within the crucial period of central auditory pathway development [10,11].

The purpose of this study was to investigate the importance of TEOAE and when aABR should be used for newborn hearing screening. In addition, secondary aim was to detect the incidence of permanent childhood hearing loss on population with and without perinatal risk factors in Duzce, Turkey.

2. Materials and methods

This retrospective study was performed at the Duzce University Faculty of Medicine in Turkey. A total of 3109 infants were enrolled, including 2933 healthy full-term infants and 176 infants with perinatal risk factors born between January 2009 and December 2013. All healthy infants were screened by using a three-stage protocol which included TEOAE and all neonates with one or more risk factors were tested aABR.

DP-Echoport ILO-292 (UK) was used for hearing screening test (TEOAE) and Maico Mb-11 (DE) was used for aABR screening advise.

Hearing screening test (TEOAE) was performed by same audiometrist. All screening tests were performed in a quiet room (noise levels below 30 dB). Infants were placed comfortably on mothers lap or bed for the test. The tests were conducted under sleep. Probe tip of various sizes were used for different neonates as required for obtaining an adequate seal. aABR measurement was started after the baby fell asleep naturally and after a feeding. All infants who passed the 35 dB hearing screen continued to the regular aABR test. Tests were performed in both ears. Infants from whom emission response was obtained bilaterally were considered to pass screening. As criteria of passing from screening, “passed” signal from the device was accepted.

Hearing screening using TEOAE was performed in newborns first time 5 days after birth (first TEOAE). Otorhinolaryngologist examined the condition of the external auditory canal and tympanic membrane with otoscopy, and nose, throat, head and face in search of ear anomalies and syndromic features related to hearing impairment that neonates failing to pass the first TEOAE. Neonates failing to pass the first TEOAE repeated TEOAE test at 15th day after birth (second TEOAE). Again neonates failing to pass the second TEOAE repeated TEOAE test at 30th day after birth (third TEOAE). Neonates failing pass third TEOAE were referred for second stage screening using aABR. In addition, neonates with risk factors (premature, low birth weight, family history of hearing loss, febrile illness during pregnancy, intermarriage, postpartum bilirubin height and remaining in intensive care) were tested with aABR in first month.

The output of screening tests was given to families and screening findings were recorded in Republic Of Turkey, Ministry of Health, Hearing Screening Program.

Data analysis and all statistical tests were performed by using SPSS for Windows (version 15.0; SPSS Inc., Chicago, IL, USA).

3. Results

In the present study, 5 days after delivery, 2933 infants not exposed to perinatal risk factors underwent TEOAE (first TEOAE) and 284 (9.6%) infants could not pass first screening. Otitis media with effusion was found in 5 (1.7%) of infants who could not pass first screening test and then retest was proposed. Of the 284 infants who could not pass the first screening test 255 (8.6%) were submitted to TEOAE again when they were 15 days old (second TEOAE). It was seen that 5 infants with otitis media with effusion passed the test at second screening. Twenty-nine (9.5%) infants

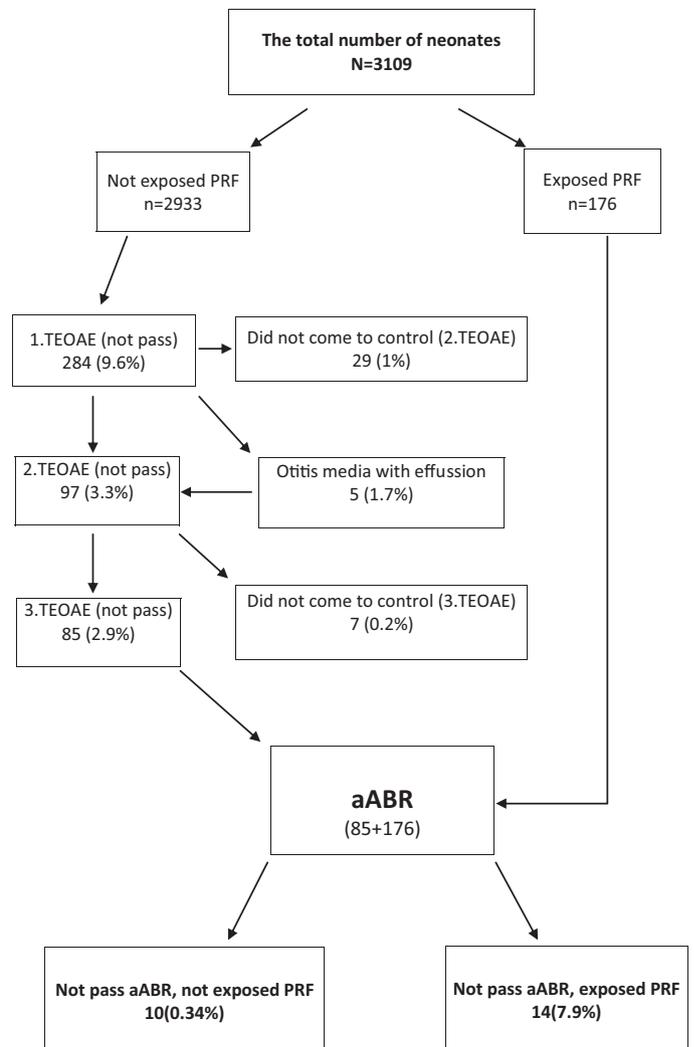
who could not pass the first screening test did not come to second TEOAE. Of the 97 (3.3%) infants who could not also pass at second TEOAE, 90 (3%) underwent TEOAE test for the third time when they were 30 days old. Seven infants (0.2%) did not come to third TEOAE. Of the 90 infants who underwent TEOAE test, 85 (2.9%) infants, not exposed to perinatal risk factors, failed again at the third TEOAE (Table 1).

In the present study, 85 (30%) of 284 infants who could not pass screening test and 176 infants exposed to perinatal risk factors underwent aABR test.

In two aABR tests made with a 2-week interval, 14 (7.9%) of 176 infants exposed to perinatal risk factors and 10 (11.7%) of 85 infants not exposed to perinatal risk factors could not pass the aABR (Chart 1). They were referred to higher center for further evaluation. As a result, in only 0.34% of 2933 healthy full-term infants was newborn hearing loss detected.

In two infants who have perinatal risk factors and could not pass aABR test suspicion of hereditary hearing loss, in one infant cleft palate anomaly, in one infant Down syndrome, in one infant external ear canal atresia was detected. In addition, overall nine infants were established to undergo treatment in newborn intensive care unit: five for low birth weight, three for high bilirubin levels, one for various reasons (Table 2).

Table 1
TEOAE and aABR for newborn hearing screening.



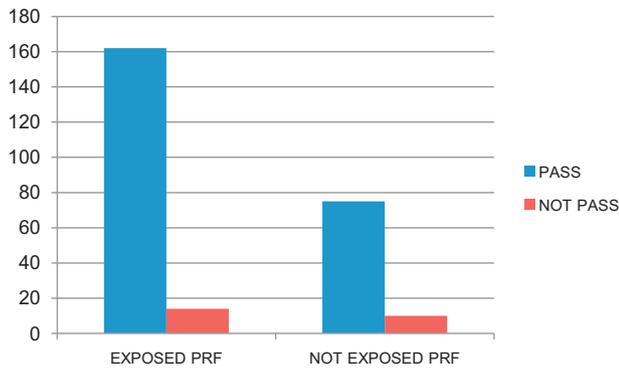


Chart 1. In aABR test exposed to perinatal risk factors and not exposed to perinatal risk factors failed to pass.

Table 2

The distribution of perinatal risk factors in infants not passed ABR.

Perinatal risk factors	Number of infants (n)	
Hereditary hearing loss	2	Second-degree relative with congenital hearing loss
Anomaly	3	Down syndrome, external ear canal atresia, cleft palate anomaly
Stayed in the neonatal intensive care unit		
High bilirubin levels	3	>12 mg/dl
Low birth weight	5	<2500 gr
Various reasons	1	As dehydration, respiratory distress

None of the infants had any history of feverish disease during pregnancy and marriage between relatives.

4. Discussion

The rate of hearing loss occurring in healthy newborn is between 0.1 and 0.6% [1,12–17]. In the present study, rate of hearing loss in healthy children was found to be 0.34% in healthy children, which is consistent with the literature. It has been reported in various studies that among children with perinatal risk factors, the rate of hearing loss may be as high as 100 per 1000 births [1,17]. Similarly, in the present study, in aABR screening carried out on infants with perinatal risk factors, newborn hearing loss was found in 7.9%.

Prieve and Stevens [18] reported that, after newborn hearing screening program was admitted, diagnosis of hearing loss can be made as early as at the mean age of 3.5 months. According to the research of Joint Committee on Infant Hearing in 1982, in developing countries, because of the paucity of resources infant hearing screening program has not been acknowledged as national program in 1982 and 1995 [19,20]. Northern and Hayes [17] his study in 1994 indicated universal screening program for infant hearing impairments was necessary, beneficial and justifiable. In our country, newborn hearing screening is mandatory within the first month. In the present study, total 24 infants were diagnosed with neonatal hearing loss at the end of the first month and they were referred to the tertiary center.

Kumar and Mohapatra [21] reported that when the infant failed the screen twice in private institutions then referral to the audiologist would be considered as hearing screening protocol in healthy newborn, Gilbey et al. [22] have used aABR after second TEOAE. Rai and Thakur [23] used aABR as the first choice in those exposed perinatal risk factors and in those who could not pass TEOAE twice. In the present study, infants who could not pass the

screening test carried out three times at certain intervals (5, 15 and 30 days after birth) were submitted to aABR test. Hence, aABR that took more time than TEOAE was required in smaller number of healthy infants (2.9%). Thereby the workload is reduced.

aABR is more suitable compared to OAE in the screening of newborn exposed to perinatal risk factors. Infants need to be in sleep state and the test is influenced from noisy environments and is time consuming [13,24]. Martines et al. [25] reported that combined TEOAE/aABR was the gold standard for Neonatal Intensive Care Unit babies which were at risk for auditory neuropathy. In the present study, aABR was used for hearing screening in neonates exposed to perinatal risk factors and healthy neonates who could not pass at least twice TEOAE. But hearing screening using only TEOAE can cause a problem to miss auditory neuropathy cases even in infants without perinatal risk factors. Because outer hair cell function with TEOAE is normal, while the eight cranial nerve and/or inner hair cell function with aABR are impaired [26]. This is a limitation to our study.

Owen et al. [12] in their study considered a unilateral pass as success in screening. In the present study, both ears were evaluated separately and infants passing the test in both ears were considered successful. Hearing loss in the other ear could not be identified if the passing from TEOAE administered to a single ear was considered adequate for passing the test. In our study of 24 infants who could not pass aABR test. Right external ear atresia was found in one. Therefore, only left ear passed from aABR test.

In conclusion, in neonates with hearing loss, it was determined that TEOAE test carried out as screening test, yielded the best results after 30-day and only 85 (2.9%) of 2933 infants without perinatal risk factors required aABR test. In conclusion, it is our belief that it is more suitable carry out hearing screening with TEOAE in healthy newborn and with aABR in newborn with risk of aABR. In addition, in healthy newborns who cannot pass at least two screening tests with TEOAE, repetition of test at various times may decrease the need for aABR significantly.

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Conflict of interest

The authors report that there are no potential conflicts of interest relevant to this article.

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