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The Effects of Mode of Delivery on Neonatal Screening Evaluated by Automated Auditory Brainstem Response

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ABSTRACT

Background/Purpose: This study aimed to investigate the role of method of delivery in neonatal hearing by comparing the automated auditory brainstem response (AABR) results of newborns born by vaginal delivery (VD) or cesarean section (CS) and to identify perinatal and neonatal factors associated with the failure of the first neonatal hearing screening test results.

Methods: This retrospective case-control study was conducted at an obstetrics clinic in Istanbul/Türkiye. Following the exclusion of newborns with incomplete data, with congenital and chromosomal anomalies, with CMV infection, and who received their hearing screening <12 h postpartum, a total of 300 newborns, 176 of whom were born by VD and 124 were born by CS were included in this study. The neonatal hearing screening was performed with AABR.

Results: A total of 181 newborns (60.3%) did not have hearing loss, whereas, in 39.7%, hearing loss was detected. A 57.4% hearing loss was reported in the VD group and 64.5% in the CS group. The difference between the groups was not significant (p = 0.13). The groups were also statistically similar in terms of family history of hearing loss, neonatal intensive care unit stay, maternal morbidity, and pregnancy complications, p values being 0.58, 0.09, and 0.14, respectively.

Conclusion: National hearing screening programs are essential for detecting hearing failure in newborns in time for a prompt diagnosis and appropriate management. Our results indicate that the method of delivery does not significantly affect newborn hearing. However, further studies are needed to resolve the conflicting findings in the literature.

Keywords: Newborn hearing screening, Automated auditory brainstem response, Mode of delivery, Vaginal delivery, Cesarean delivery

Doğum Şeklinin Yenidoğan İşitme Sonuçları Üzerindeki Etkisinin İşitsel Beyin Sapı Yanıtı ile Değerlendirilmesi

ÖZET

Amaç: Bu çalışma, vajinal doğum (VD) veya sezaryen (CS) ile doğan yenidoğanların otomatik işitsel beyin sapı yanıtı (AABR) sonuçlarını karşılaştırarak yenidoğan işitmesinde doğum şeklinin rolünü araştırmayı ve ilk yenidoğan işitme tarama testi sonuçlarının başarısızlığı ile ilişkili perinatal ve neonatal faktörlerin tanımlanmasını amaçlamıştır.

Yöntemler: Bu retrospektif vaka-kontrol çalışması, İstanbul'da bir kadın doğum kliniğinde yapılmıştır. Verileri eksik, konjenital ve kromozomal anomalileri olan, CMV enfeksiyonu olan ve postpartum 12. saatten önce işitme taraması yapılan yenidoğanların dışlanmasının ardından 176'sı VD, 124'ü CS ile doğmuş olmak üzere toplam 300 yenidoğan bu çalışmaya dahil edilmiştir. AABR ile yenidoğan işitme taraması yapılmıştır.

Bulgular: Toplam 181 yenidoğanda (%60,3) işitme kaybı görülmezken, %39,7'sinde işitme kaybı saptanmıştır. VD grubunda %57,4 ve CS grubunda %64,5 işitme kaybı bildirilmiştir. Gruplar arasındaki fark anlamlı değildir (p = 0.13). Gruplar ayrıca ailede işitme kaybı öyküsü, yenidoğan yoğun bakımda kalış süresi, annede hastalık ve gebelik komplikasyonları açısından da istatistiksel olarak benzer görülmüştür; p değerleri sırasıyla 0.58, 0.09 ve 0.14'tür.

Sonuç: Ulusal işitme tarama programları, erken tanı ve uygun tedavi için yenidoğanlarda işitme yetersizliğini zamanında tespit etmek açısından gereklidir. Sonuçlarımız, doğum şeklinin yenidoğan işitmesini önemli ölçüde etkilemediğini göstermektedir. Bununla birlikte, literatürdeki çelişkileri gidermek için daha fazla çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Yenidoğan işitme taraması, Otomatik işitsel beyin sapı yanıtı, Doğum şekli, Vajinal doğum, Sezaryen doğum

Neonatal hearing loss is a birth abnormality common in infants, but, being hidden, is difficult to diagnose. Early diagnosis allows early intervention and rehabilitation of language and communication skills, minimizing the effects of hearing loss on development (1). The National Newborn Hearing Screening Program, initiated in 2004, is a nationwide program to detect hearing loss in newborns in Turkey. Otoacoustic emission (OAE) testing and automated auditory brainstem response (AABR) are commonly used screening methods in newborns (2). On average, a hearing loss of 30 to 40 decibels (dB) can be detected with both methods (3). An incidence of 0.1–0.3% has been reported in the literature for neonatal hearing impairment (4, 5).

There are many factors associated with hearing screening failure in newborns. Among these are facial/auricular malformations, external ear canal secretions, middle ear effusion, familial deafness, use of epidural anesthesia in cesarean deliveries, vaginal delivery, emergency cesarean section, 5 minute Apgar score <5, neonatal intensive care unit (NICU) stay, hyperbilirubinemia, and OAE test performed within the first postpartum 24 h (6-8). In an observational retrospective study, it was reported that hearing screening test failure was higher in babies born by cesarean section (CS) than in babies born vaginally (VD) (9). This led to a higher need for repeated testing, resulting in increased parental anxiety, mental stress, and increased medical costs (9). Therefore, it is of great importance to identify the factors that adversely affect newborn hearing screening tests.

Inconsistent findings regarding the effects of the method of delivery on the hearing screening results were reported in the literature. This was primarily due to a high rate of false positives (FP). A high FP rate was observed in most studies, where a higher rate of hearing screening failure was associated with CS delivery. However, the real reason for hearing failure was ear debris and/or effusion, not CS delivery (7, 9, 10). On the other hand, other studies evaluating VD and neonatal hearing loss reported higher FP rates (11).

In this study, we aimed to investigate the role of the method of delivery in neonatal hearing by comparing the AABR results of newborns born by VD or CS and identifying perinatal and neonatal factors associated with failure of the first neonatal hearing screening test results.

Material and Methods

This retrospective case-control study was conducted at the Department of Obstetrics and Gynecology of the University of Health Sciences Turkey, Istanbul Kanuni Sultan Suleyman Training and Research Hospital between December 2018 and June 2019. The study protocol was approved by the institution's Ethics Committee (KAEK/2018.9.16) and registered to ClinicalTrials.gov (NCT03881514). Written informed consent was obtained from all subjects.

Following ethical approval, the hospital's electronic database was searched for the results of all births within the study period. Out of the >10,000 women who gave birth at our clinic during the study period, the data from 3000 women who had their prenatal follow–ups at our hospital, with available complete records, whose newborns' hearing screening results could be acquired from the database, and who consented were retrieved from the database. Then, newborns with congenital and chromosomal anomalies, with CMV infection, with anatomical deformities involving the face and the ears, and who received their hearing screening <12 hours postpartum were excluded. A further exclusion was undertaken based on maternal history, including maternal infections, recurrent pregnancy loss, smoking, and alcohol abuse. Following the exclusion, a total of 300 newborns, 176 of whom were born by VD and 124 by CS, were included in this study (Figure 1).

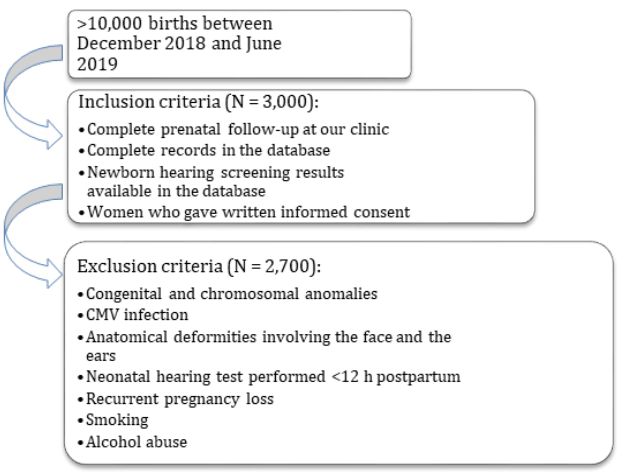

Figure 1. *Study cohort selection with inclusion and exclusion criteria.*

According to the Turkish Ministry of Health's Newborn Hearing Screening Program, all newborns should be screened with AABR before discharge from the hospital. According to our hospital's policy, all mothers and newborns without complications are discharged after 24 h of VD and 48 h of CS, and all newborns receive their hearing screening tests between 24-32 h postpartum. In cases of complications and discharge on weekends, the hearing tests are delayed to the earliest possible day thereafter. The test is performed in a quiet room by an audiologist. The newborn should be quiet (preferably asleep or while breastfeeding), and ambient noise should be kept as low as possible. The test can be done without sedation, and lasts 5-15 min. A Madsen AccuScreen (GN Otometrics A/S, Taastrup, Denmark) device was used in this present study.

The test results of the newborns were recorded as fail-pass separately for the right and left ears. Additionally, newborns' perinatal and postnatal evaluations, need for care in thee NICU following birth, delivery method, gestational age at birth, birth weight, sex of the newborn, Apgar scores (1-5 min), hyperbilirubinemia, maternal comorbidities and pregnancy complications including type 1 and type 2 diabetes mellitus, gestational diabetes mellitus, intrauterine growth retardation, gestational hypertension, hypothyroidism, and placenta previa, and time of the first AABR were retrieved from the database.

The Statistical Package for the Social Sciences version 20 (SPSS, Inc., Chicago, IL, USA) was utilized in data analysis. Continuous variables were reported as mean ± standard deviation. Percentages and values as numbers were given for categorical variables. Data distribution was assessed with the Kolmogorov–Smirnov test. Means were compared either with the Mann–Whitney U or the Student's t-test. Chi-square and Fisher's exact tests were used to compare categorical variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 300 newborns, 176 (58.7%) in the VD group and 124 (41.3%) in the CS group, were included in this study. The demographic characteristics of all the newborns are displayed in Table 1. The mean maternal age was 26.7 years. The mean gestational age at birth was calculated to be 37.8 weeks. The median 1 min Apgar score was 8 and the 5 min Apgar score was 10. Of the newborns, 55.3% of the newborns were boys, and 44.7% were girls. A failed test result was detected in 31.3% of the newborns in the right ear and 32.7% in the left ear. A total of 181 newborns (60.3%) did not have a hearing loss, whereas, in 39.7%, hearing loss was detected.

Table 1. Demographic characteristics of all newborns

		All Newborns (n=300)
Age (mean± SD)		26.7 ±6.1
Gravidity (mean± SD)		2.6±1.4
Parity (mean± SD)		1.4±1.1
Weeks of gestation at birth (mean± SD)		37.8±2.2
Apgar 1 (median (min-max))		8(3-9)
Apgar 5 (median (min-max))		10(6-10)
Test timing (mean± SD)		6346.66±31248.68
Birth weight (g) (mean± SD)		3100±500
Maternal morbidity and pregnancy complications	None	267(%89)
	Present	33(%11)
Mode of delivery	VD	176(%58.7)
	CS	124(%41.3)
Sex	Boy	166(%55.3)
	Girl	134(%44.7)
ABR fail	Right	94(%31.3)
	Left	98(%32.7)
Hearing loss	No	181(%60.3)
	Yes	119(%39.7)
NICU stay	No	262(%87.3)
	Yes	38(%12.7)
Hyperbilirubinemia	No	297(%99)
	Yes	3(%1)
Family history of hearing loss	No	299(%99.7)
	Yes	1(%0.3)

The mean gravidity and parity were reported to be similar between the VD and the CS groups (Table 2). However, the mean weeks of gestation at birth (p = 0.02), 1 min Apgar score (p = 0.007), and 5 min Apgar score (p = 0.005) were significantly lower in the CS group. A 57.4% hearing loss was reported in the VD group and a 64.5% hearing loss in the CS group. The difference between the groups was not significant (p = 0.13). The groups were also statistically similar in terms of family history of hearing loss, NICU stay, maternal morbidity, and pregnancy complications, p values being 0.58, 0.09, and 0.14, respectively.

Table 2. Comparison between VD and CS Groups				
		VD Group (n=176)	CS Group (n=124)	p–value
Age (mean±SD)		25.6±6.03	28.3 ±6.02	<0.001
Gravidity (mean±SD)		2.5±1.4	2.8±1.4	0.15
Parity (mean±SD)		1.3±1.1	1.4±1.1	0.37
Weeks of gestation at birth (mean± SD)		38.1±1.4	37.5±3.04	0.02
Apgar 1 (median (min-max))		8(6-9)	8(3-9)	0.007
Apgar 5 (median (min-max))		10(8-10)	10(6-10)	0.005
Test timing (mean± SD)		3612.45± 5379.92	10291.09± 48253.43	0.13
Birth weight (g) (mean± SD)		3100±400	3100±500	0.83
Maternal morbidity and pregnancy complications	No	160(%90.9)	107(%86.3)	0.14
	Yes	16(%9.1)	17(%13.7)	
Sex	Boy	99(%56.3)	67(%54)	0.39
	Girl	77(%43.8)	57(%46)	
Hearing Loss	No	75(%42.6)	44(%35.5)	0.13
	Yes	101(%57.4)	80(%64.5)	
NICU stay	No	158(%89.8)	104(%83.9)	0.09
	Yes	18(%10.2)	20(%16.1)	
Hyperbilirubinemia	No	174(%98.9)	123(%99.2)	0.62
	Yes	2(%1.1)	1(%0.8)	
Family history of hearing loss	No	175(%99.4)	124(%100)	0.58
	Yes	1(%0.6)	0(0)	

Discussion

For the first time, in 1999, the American Academy of Pediatrics recommended the implementation of a screening methodology to assess newborn hearing. Since then, the screening program has been proven to be safe and effective in the early detection of newborn hearing impairment (12-14). However, the implementation of proper neonatal hearing screening remains a challenge in developing countries. In developed countries, screening is performed in obstetrics clinics before newborns are discharged from hospital (15). During hospitalization, tests may be repeated up to three times in case of failure at the initial screening. If a failed result is obtained from the last test before discharge, a routine follow-up examination, including OAE testing and automated ABR, is performed after 30-42 days (16).

Conflicting results regarding the role of mode of delivery in hearing screening have been reported in the literature. In a study conducted in China that included 1,460 newborns, newborns born by CS were shown to have three times higher failure rates on the OAE test than newborns born by VD (16). Smolkin et al. reported a 3.2-fold higher failure rate in the first OAE of babies born by CS when compared to VD (9). Furthermore, they observed that the difference was found at 42-47.9 h after birth (9). Accordingly, they suggested that the hearing screening test should be performed after 48 h of birth to minimize the failure rates (10). The high test failure rate may be due to the short hospital stay of the mothers and, accordingly, the early testing after delivery (10). On the other hand, Al-Balas et al. reported higher failure rates with VD, and Güven reported no difference between the groups (17, 18). In our study, we observed no difference between the CS group and the VD group regarding hearing screening results.

One of the major reasons for this discrepancy in the literature is high FP rates. However, authors have reported different FP rates for both groups. Farahani et al. reported a significantly higher rate of FP in the VD group in the first screening tests than the CS group, whereas Olusanya et al. reported a higher rate of FP in the latter group (11, 19). One of the causes of high FP rates is the presence of ear canal effusion. Balkany et al. examined 50 term newborns in the first 24 h postpartum and reported that 30% of the babies who were being cared for in the NICU had middle ear effusions (20). Another study showed that, following the removal of secretions from the external auditory canal, the success rate of screening increased from 76% to 91% (6).

The effect of additional factors such as low Apgar scores, gender of the newborn, weeks of gestation at birth, and birthweight of the newborns on hearing screening test results have also been evaluated in the literature and in our study. Smolkin et al. reported no correlation between Apgar scores and hearing screening test failure (9). Again, in the same study, male gender was associated with an increased risk (1.4 times) of failure in the first screening test (9). When the OAE test results of female newborns were compared with males, better results were reported in terms of whole-wave reproducibility, response level, band reproducibility, and signal-to-noise ratio (21). There were no significant differences between our study groups in terms of newborn birthweight and gender of the newborns indicating that birthweight and gender do not significantly affect hearing screening. Additionally, although the CS group had significantly lower Apgar scores

and weeks of gestation at birth, since there were no differences between the groups in terms of hearing screening results, we could conclude that these factors did not play a significant role in the hearing of the newborns.

The adverse effect of a failed first OAE on maternal anxiety has already been documented (22). Although maternal knowledge and awareness of hearing screening have increased, the degree of maternal anxiety has been reported to be higher in the retest than in the first hearing test (23). Minimizing neonatal FP rates is also important in allaying parental concerns. Delaying the timing of the screening has been shown to decrease the FP rates in some studies (24). Vernix and middle ear effusions are the most critical factors affecting FP rates in the screening test. Cleaning the ear canal and facilitating maneuvers to reduce middle ear effusions can reduce the rate of FP (25). In addition, performing the screening test in a separate room and postponing it until discharge from the hospital can reduce the rate of FP in the first screening test (19). Thus, the cost and stress for families can be reduced.

This study has some limitations. First, the study was retrospective in design, and the authors did not consider possible changes in temporally induced screening tests in the first month of life. Additionally, we were only able to observe the factors associated with screening failure, not to evaluate the exact mechanisms involved. Second, an otoscopic examination of newborn infants was not performed to clear external ear secretions or exclude middle ear effusions. However, there are conflicting results regarding the effects of the mode of delivery on the hearing screening of newborns. Recent studies such as ours suggest that the method of delivery does not play a significant role in the results of hearing screening. Randomized controlled studies with larger cohorts are needed to arrive at a conclusion.

Conclusion

National hearing screening programs are essential for detecting a hearing failure in newborns in time for a prompt diagnosis and appropriate management of the newborns. However, it is also essential to understand which factors affect newborn hearing, and to achieve accurate results to minimize FP. Our results indicate that the method of delivery does not significantly affect newborn hearing. However, further studies are needed to resolve the conflicting findings in the literature.

Declarations

Ethical Approval

Kanuni Sultan Suleyman Training and Research Hospital Ethics Committee, (KAEK/2018.9.16)

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Data Availability Statement

Research data is available upon request.

Conflict of Interest

The authors declare that they have no conflict of interest.

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