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The effects of mode of delivery, maternal age, birth weight, gender and family history on screening hearing results: A cross sectional study

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ABSTRACT

Introduction: Congenital hearing impairment is one of the principal issues that make distress to families especially those with a family history of hearing problems. Early detection of hearing impairment can make a difference regarding cognitive, attention, learning, speech, and social and emotional development of babies. Otoacoustic test emission is a very common screening test that can be used to pick up early cases and relieve family stress. We tried to evaluate the factors that may disrupt our results regarding the OAE test.

Methods: A cross-sectional study included infants who were admitted to the nursery unit alone. Infants who were admitted to the NICU unit, infants with craniofacial anomalies, infants with vernix in the external auditory canal, and Infants with Stigmata associated with a syndrome known to include a sensorineural hearing loss were excluded from the study. Both transient evoked otoacoustic emissions (TEOAE) with distortion product otoacoustic emissions (DPOAE) Screening tests were performed by the same professional audiologist experienced in neonatal screening.

Results: A total of 1413 newborns (733 males and 680 females) were included in the study. Among them, 1368 babies (96.8%) passed the first OAE in both ears, while 45 babies (3.2%) didn't pass the first OAE in one or both ears.Significant correlations between the female gender and family history of congenital hearing loss with failure of the first OAE test results. Moreover, vaginal delivery (VD) infants had a 1.5-fold higher failure rates of first OAE test screening results in comparison to caesarian delivery (CD) infants.

Conclusion: Our study demonstrated higher failure rates of the first OAE in female infants, vaginal delivery infants, and infants with a family history of hearing impairment. It is recommended to postpone the first phase of hearing screening for those infants until the first scheduled vaccine appointment to achieve higher compliance attendance, and decrease family stress associated with false-negative results of the test.

1. Introduction

Hearing impairment is considered one of the leading causes of sensory diseases at birth [1]. Its prevalence is estimated to be 1–6 per 1000 live births worldwide [2–4], and 15 per 1000 Jordanian live births [5]' the prevalence rate of reported hearing loss increasing globally [6].

Hearing impairment can have a deeply negative consequence on cognitive, attention, learning, speech, and social and emotional development [7–11]. so that, the management of congenital hearing loss requires cooperation between different teams to perform a multidisciplinary approach to manage those patients started with audiologists and otolaryngologists finished by parents and school involvement. Where the role of otolaryngologist summarized by pick up the cases, investigate the cause and development of treatment plan.

Hence early identification of HL can avoid these complications; the American Academy of Pediatrics (AAP) has recommended universal newborn hearing screening (UNHS) since 1999 [12] for every newborn at any time before discharge from the hospital [13]. Accordingly, two techniques are used in UNHS: otoacoustic emissions (OAE) and automated auditory brainstem response (AABR) [14,15]. OAE test is more

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commonly used and provides an easy, fast, efficient, inexpensive, and non-invasive method [16–18].

Many factors can affect the test and are related to increasing screening failure rates in infants. These factors involve Hispanic race [19], familial hearing impairment [19,20], face or auricle deformity [20], middle ear effusion [20], secretions in the external ear canal [20], small for gestational age (SGA) status [21], male gender [21], epidural anesthesia during cesarean delivery (CD) [22], the CD itself [21], vaginal delivery (VD) [23,24], emergency CD [23], birth weight of less than 2500 g [21], Apgar score of less than 5 at 5 min [23], need for critical care, significant hyperbilirubinemia [23,24], and early-1st OAE before 24 h of age [21,25].

In this study, we try to investigate the effect of the mode of delivery, maternal age, gestational age, gender and the history of hearing loss in the failure rate of first OAE among Jordanian infants in the nursery unit.

2. Materials & methods

Registration and ethics: Research Registry number is stated, in accordance with the declaration of Helsinki. Unique identifying number: researchregistry6555 (https://www.researchregistry.com/browse-the-registry#home/registrationdetails/6023cf602af200001baf61c2/).

Ethical approval: The study was approved by the Institutional Review Board (IRB) in King Abdullah Hospital.

This cross-sectional study took place over one year, between the 1st of September 2017 and the 31st of July 2018, in King Abdullah University Hospital (KAUH), a tertiary referral hospital in the north of Jordan. We include infants who were admitted to the nursery unit alone. Infants with one of the following were excluded from the study.

1. Infants admitted to the NICU unit
2. Infants with morphological abnormalities of the pinna and ear canal.
3. Infants with vernix in the external auditory canal
4. Infants received Ototoxic medications during the neonatal period
5. Infants with APGAR scores of 0–4 at 1 min or 0–6 at 5 min
6. Infants with features or findings associated with a syndrome associated with sensorineural hearing loss.

The screening was conducted within the first 48 h after delivery for healthy newborns. Both transient evoked otoacoustic emissions (TEOAE) with distortion product otoacoustic emissions (DPOAE) Screening tests were performed by the same professional audiologist experienced in neonatal screening.

Three phases of the screening were implemented within three months of delivery. During the first phase newborns were screened prior to discharge, were both ears were screened separately. Results of screening were either “pass” or “refer”. Pass results indicated that babies have presumably good hearing level refer results in one or both ears, means that baby should be referred for the second phase of hearing screening. All babies who had “refer” results were given an appointment for a second OAE test in our audiology department 2–4 weeks after delivery depending on the mother’s gynecology clinic visit or the infants’ pediatrics clinic visit to ensure compliance. If the baby failed the second OAE test, a diagnostic Auditory Brain Stem Response (ABR) test appointment was performed.

This paper is prepared in compliance with STROCSS 2019 criteria [43]. Data were recorded in a Microsoft Excel (Redmond, WA, USA) spreadsheet and analyzed by SPSS program version 16.0, Statistical significance was assessed using a two-tailed Fisher’s exact test (statistical significance was considered for $p < 0.05$).

3. Results

1413 babies in the nursery unit were screened for hearing impairment. Among them 733 infants were male and 680 were female. 1368 babies (96.8%) passed the first OAE in both ears, while 45 babies (30 females and 15 male) didn’t pass the first OAE in one or both ears with a rate of 3.2%. There was a statistical correlation between the gender and passing the OAE test with a *P*-Value of 0.01 (Table 1).

Regarding mode of delivery, 844 infants (59.7%) were born by CD and 569 (40.3%) by VD. Among infants born by CD, infants who didn’t pass the first OAE was 22 (2.6%) in comparison to 23 infants from the VD group (4%). Accordingly, VD infants had a 1.5-fold higher failure rate of first OAE test screening results compared to CD infants (4.0% vs 2.6% respectively) but with no statistical significance (Table 2). Patients with family history of congenital hearing problems (n = 58) had significantly higher rate of failed first OAE in comparison to those without family history (18.9% vs. 2.5%; $P = 0.0001$). Table 3.

Infants who failed their first OAE screening test (n = 45) were given appointments two weeks after being discharged for second test. Among them, 42 infants passed their 2nd screening test with no correlation with previously reported factors affected their first screening test results. Infants who failed the 2nd test were scheduled for auditory brainstem response (ABR), only one patient proved to have congenital hearing loss.

Regarding infants with family history of congenital hearing loss, female gender and those born with vaginal delivery, delaying the first OAE screening test may reduce family stress secondary to false negative results. No correlations between maternal age, gestational age and failure of the OAE test were identified.

4. Discussion

Hearing impairment is one of the commonest birth disorders in infants and because it’s an occult defect, it’s difficult to diagnose it early without screening programs approximately between 12 and 36 months which is a very important period of infant development [26]. For lowering the mean age of hearing impairment detection, the universal newborn hearing screening (UNHS) program is the most effective way for early identification of hearing impairment [27,28] so early intervention and rehabilitation which is effective in language development in infants [11,28].

OAE is the most common procedure used in UNHS, it’s simple, safe, painless, very sensitive to mild impairments, and done while the child is resting quietly [29]. Consequently, 95% of mothers supported UNHS [30] but the maternal worry was significantly higher after the failure of the first OAE despite that the maternal knowledge about hearing screening increased after this failure [31]. This failure in the first OAE can have a negative effect on the relationship between infants and their parents especially mothers [32,33]. So to improve this test, it’s important to detect the causes that affect the OAE results. Accordingly, in this study, we investigate the association between first OAE failure and mood of delivery, family history of hearing loss, gender, and maternal age.

Our results show that the failure rate in the first OAE in VD infants is 1.5 fold higher than CD infants, which is similar to the Farahani ratio [34] who found that the failure rate was 15.5% in VD infants and 9.5% in CD infants. Likewise, Olusanya et al. [24] stated that VD is associated with more than two-fold risk than a CD. On the other hand, Xiao et al. [35] found that 89 (21.0%) CD infants failed the first test out of 423 infants while 74 (7.1%) VD infants out of 1037 failed the test, which means that the rate of failure was 3 fold in CD infants; also Smolkin et al. [21] found that failure rate was 3.2 higher in CD infants compared to VD infants (20.7% vs. 7.1%).Notwithstanding, in our analysis, the difference between CD and VD was not statistically significant with the failure

Table 1
The first Screening test results for the 1413 infants enrolled in the study.

First OAE screening phase	Male	Female	Total
Pass the test	718	650	1368
Fail the test	15	30	45
Total	733	680	1413

Table 2
The relation between mode of delivery and the first OAE test results.

First OAE screening phase	Infants born by Caesarian delivery	Infants born by Vaginal delivery	Total
Pass the test	822	546	1368
Fail the test	22	23	45
Total	844	569	1413

Table 3
Family history of hearing problems and it is impact on OAE test results.

First OAE screening phase	Family history of hearing problems	No Family history of hearing problems	Total
Pass the test	47	1321	1368
Fail the test	11	34	45
Total	58	1355	1413

rate of first OAE, which is similar to Güven [4] and Shahid [19] findings. On the contrary, previous studies reported that VD is a statically significant risk factor for first OAE failure [24,34,36]. Whereas others reported that CD appears to be a risk factor [21,35,37–39].

We found a strong statistically significant association between family history of hearing impairment and failure in the first OAE. In common with our finding, Shahid et al. [19] found on his retrospective chart review that 6 (50.0%) infants out of 12 who have a family history of congenital hearing loss failed the first OAE. On the other hand, just 102 (8.1%) infants out of 1158 without a family history of congenital hearing loss did not pass the test ($P = 0.0002$). Also, Shahid et al. [19] reported that the odds of first OAE failure rate of infants with a family history of hearing impairment were 11 times higher than the odds of infants without a family history. On the other hand, Karaca et al. [36] and Bener et al. [40] stated that a family history of hearing impairment wasn't statistically significant between the two groups.

Saitoh et al. [42] found that the male gender was a risk factor for failure OAE test. Smolkin et al. [21] in his retrospective observational study found that 110 (12.7%) male infants failed the first OAE out of 866 males while only 73 (9.3%) failed out of 787 female infants, which indicates that the male gender increased the risk of the first OAE failure by 1.4 fold. On the other hand, many studies didn't find a significant association between the failure of the first OAE and the gender of the infant [19,35,36,41]. However, in our study, there was a statistical correlation between the female gender and failing the first OAE test results.

Our finding shows there are no statically correlations the maternal age and passing the first OAE test. As well as Bener et al. [40] found there were no significant differences according to maternal and paternal age. Moreover, we didn't find a significant correlation between birth weight less than 2500 g and the failure of OAE which is similar to Shahid et al. [19] and Karaca et al. [36] findings. On the other hand, Smolkin et al. [21] found that birth weight less than 2500 g is significantly associated with failure of the first OAE but there is no proper explanation why those infants had more failure rate in the first OAE but it may be due to perinatal conditions related to their case [41]. Otherwise, Olusanya et al. [24] and Karaca et al. [36] stated that low birth weight less than 1500 g is a risk factor to failure the first OAE.

5. Conclusion

Our study suggests higher failure rates of the first OAE in female gender infants, vaginal delivery infants and infants with a family history of hearing impairment. we recommend to postpone the first phase of hearing screening for those infants until the first visit after discharge in order to decrease false negative results related family stress. Generally, it is recommended to schedule the screening test at the time of vaccine appointment to achieve higher compliance attendance.

5.1. Limitations and challenges

Long-term follow up for those infants with negative OAE test results had a risk of loss of the follow up; this was managed by registration more than one contact number of the family and official schedule appointment in the hospital for the second appointment. Moreover; families who refused early screening were managed by counseling about the importance of this test.

Ethical approval

Ethical approval from the institutional review board in King Abdullah University Hospital.

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Author contribution

HIB, AN designed the study. MZ performed auditory tests. HIB and MZ collected the data and performed the data analysis. All authors contributed to the interpretation of the results. HIB, AK wrote the first draft of the manuscript. MA edited and revised the manuscript. All authors met criteria for authorship and approved the final manuscript.

Research registration number

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2. Unique Identifying number or registration ID: researchregistry6555.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-the-registry#home/registrationdetails/6023cf602af200001baf61c2/.

Guarantor

The corresponding author is the guarantor for the work and he has the responsibility of access to the data, and controlling the decision to publish.

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Declaration of competing interest

The authors have no potential conflicts of interest to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.102236.

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