Original Article

Neonatal Hearing Screening, with Otoacoustic Emission, among Normal Babies in a Northeastern Nigerian Hospital

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Abstract

Background: Hearing is necessary for speech and language development, children with bilateral hearing loss often have impaired speech and language abilities thus limiting educational attainment. Early detection and intervention will help minimize such effects. Therefore, neonatal hearing screening program has been advocated in developing countries. **Objective:** TThe objective of this study is to determine the prevalence of hearing loss and risk factors among full-term inborn neonates delivered in a University Teaching Hospital with transient evoked otoacoustic emission (TEOAE). **Materials and Methods:** All full-term neonates delivered in a University Teaching Hospital were included in this prospective cross-sectional study. The hospital's ethical committee gave approval. The researcher obtained informed consent from the parents and administered a questionnaire for demographic, prenatal, and postnatal data. A comprehensive head and neck examination preceded the preliminary otoscopy. With the help of a hand-held otodynamic otoport, Neonatal Hearing Screening Program otoacoustic emission (OAE), each ear's hearing was assessed. Statistical Product and Service Solutions (SPSS) version 22.0 was used to analyse the data. **Results:** 150 full-term neonates were screened, of which 72 (48%) were males and 78 (52%) were females. Neonates that failed the TEOAE in both ears were 12 (8%). 18 (12%) neonates had a refer in right ear only, while 24 (16%) had a refer in the left ear only. The only significant risk factor with a referral outcome of TEOAE was family history of childhood hearing loss (23.1%). **Conclusion:** This study found a high prevalence (8%) of failed TEOAE of full-term neonates delivered in our hospital with a significant risk factor of family history of childhood hearing loss.

Keywords: *Hearing loss, hearing screening, neonate, otoacoustic emissions*

Introduction

Hearing impairment in children across the world constitutes a particularly serious obstacle to their optimal development and education, including language acquisition. According to a range of studies and surveys conducted in different countries, around 0.5–5 in every 1000 neonates and infants have congenital or early childhood onset sensorineural deafness or severe to profound hearing impairment.[1] The Joint Committee on Infant Hearing endorses early detection of and intervention for infants with hearing loss. The goal of early hearing detection and intervention is to maximize linguistic competence and literacy development for children who are deaf or hard to hear.[2]

Adequate hearing within the first year of life is critical in the development of speech and cognitive functions of infants. Beyond this period, neural plasticity sets in, especially after the 3rd year.[3,4] Studies on the prevalence of congenital hearing loss in the developing world including Nigeria are scanty. This is as a result of poverty, low socioeconomic status, unavailability of resources, and misplaced priorities, such that hearing loss is not considered as a burden.[5]

Nigeria is suggested to have the highest proportion of developmentally disadvantaged children in the world. Preliminary study from screening 2003 neonates at Bacilus Calmette-Guerin (BCG) immunization clinics using two-staged protocol of transient evoked otoacoustic emission (TEOAE) and auditory brainstem response (ABR) audiometry reported a referral of 14.3% with TEOAE; of these 19.8% passed and 28.6% were referred for diagnostic evaluation.[6]

According to most recent international guidelines, the deafness diagnosis must occur before the age of 3 months while prosthetic rehabilitative treatment with a traditional

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hearing aid and restorative treatment with cochlear implantation should start within the first 6 months.[7]

Hearing loss is defined as a decrease in the ability to detect sound. It can be bilateral or unilateral. Hearing impairment may be classified as either congenital or acquired; it can also be prelingual (before acquisition of speech) or postlingual (after acquisition of speech).[8] In this study, hearing loss occurring at birth up to the first 28 days of life will be considered as neonatal hearing loss.

It can be classified according to the site of lesion, severity, aetiology, and type of occurrence. Based on the site of lesion, it can be conductive hearing loss when the lesion affects the external ear, tympanic membrane, and middle ear cleft including oval window and the Eustachian tube. If the lesion is in the cochlear or neural pathway, it is referred to as sensorineural hearing loss. Sensorineural hearing loss may further be divided into cochlear or retrocochlear loss. Lesion causing both conductive and sensorineural hearing loss is called mixed hearing loss.[9]

The aim of this study was to screen the hearing of full-term normal neonates delivered in our hospital, using TEOAE, so as to assess the prevalence of hearing loss and determine risk factors for failed TEOAE among them.

Materials and Methods

This study was a prospective, cross-sectional, single-stage study of normal full-term inborn neonates, who were within 72 h of age, seen in the labour and postnatal wards of the hospital. Ethical approval to conduct the study was sort and obtained from research and ethics committee of the hospital, and it was conducted over a 6-month period between November 2019 and April 2020.

Included in the study were all full-term normal inborn neonates within 72 h of age in the labour ward and those in the postnatal ward whose parents gave consent for the study. Excluded from the study were those neonates whose parents did not give consent, neonates with craniofacial anomaly, preterm neonates, and neonates with congenital ear anomalies, e.g., microtia, meatal stenosis, and ear discharge.

Demographic data were collected using a questionnaire that was administered by the principal researcher to the mothers of the neonates after signing the informed consent. Subsequently, a complete ear, nose, throat, head, and neck examination was appropriately done with the babies mostly in the couch or on the mother's lap; otoscopy was carried out on all the neonates using Heinz otoscope. The external auditory canal of the neonates that had debris was cleaned before the procedure by using cotton wool ribbon over small orange sticks, but most of them were cleaned by gentle suctioning.

The procedure was performed using a portable hand-held Otodynamics Otoport Neonatal Hearing Screening Product (NHSP) otoacoustic emission (OAE) screening unit, with serial number: OPN/10012477, manufactured by Otodynamics Ltd (Hatfield, UK). A small probe was placed in the external auditory canal of the neonates. This probe delivered a low-volume, transient-evoked OAE stimulus into the ear. The cochlear responded by producing an OAE that travelled back through the middle ear to the ear canal and was analysed by the screening unit. In approximately 30 s, the result was displayed on the screening unit as "PASS" or "REFER." For those who had inconclusive results due to either debris or restlessness and excessive movements, the procedure was repeated within 72 h, but the following day in most of the neonates. Those with "REFER," that is those with suspected hearing impairment, were counselled and subsequently referred for rescreening and complete audiological evaluation. Data obtained were entered into Statistical Product and Service Solutions (SPSS) spreadsheet and analysed using SPSS software version 22.0 for windows. Data were summarized and presented as quantitative and qualitative variables, which were depicted using tables and graphs. Qualitative variables were expressed as frequencies and percentages. The chi-squared test and Fischer's exact test were used to establish associations between categorical variables, with a *P* value of less than .05 considered as being significant.

Results

Out of the 150 neonates screened, 72 (48%) of them were males and 78 (52%) were females, with a female to male ratio of 1.08:1. The mean gestational age at birth calculated from the last menstrual period was 37.6 weeks with a standard deviation of ±1.02 week. Table 1 outlines the sociodemographic profile of subjects.

Table 1: Sociodemographic profile of subjects

Variable	Frequency, *n* (%)	Percentage (%)
Gender		
Male	72	48
Female	78	52
Father's occupation		
Civil servant	57	38
Business	67	44.7
Self employed	26	17.3
Mothers occupation		
Civil servant	25	16.7
Business	9	6
Self-employed	3	2
Student	3	2
Housewife	110	73.3
Educational background of mother		
University	32	
Secondary	82	
Primary	16	
No formal education	20	
Antenatal care booking		
Yes	125	
No	25	
Mode of delivery		
Spontaneous vaginal delivery	119	79.3
Caesarean section	31	20.7

Table 2: Outcome of neonatal hearing screening with TEOAE

Outcome	Right ear	Left ear	Both ears
Pass	132 (88%)	126 (84%)	138 (92%)
Refer	18 (12%)	24 (16%)	12 (8%)

TEOAE: transient evoked otoacoustic emission
Referral rate for neonatal hearing screening with TEOAE is 12 per 150 neonates = 8%

Table 3: Association between risk factors and failed TEOAE

Risk factor	Failed (%)	Passed (%)	*P* value (%)	Odds ratio
Family history of childhood HL	3 (23.10)	10 (76.9)	.047	4.27
Maternal infection (fever)	1 (20)	4 (80)	.345	3.045

HL: hearing loss, TEOAE: transient evoked otoacoustic emission

None of the mothers gave history of use of ototoxic medication during pregnancy. Family history of childhood hearing loss was found in 13 (8.7%), whereas those whose mothers had maternal infection (fever) during pregnancy were five (3.3%).

In this study, a PASS in one or both ears is considered a pass, whereas a REFER in both ears is considered a fail. A total number of those that passed the TEOAE were 138 (92%), whereas those who failed the TEOAE were 12 (8%). Table 2 shows the outcome of the hearing screening.

Two (1.3%) of the 12 neonates who failed the TEOAE were males, whereas 10 (6.7%) of the 12 neonates who failed the TEOAE were females. The *P* value was .024, which was statistically significant.

The Fischer's exact test revealed a statistically significant relationship between family history of childhood hearing loss and a referral outcome with TEOAE [Table 3].

Discussion

Hearing loss is a hidden disability that does not attract much sympathy like other physical disabilities. Universal hearing screening represents the only way to identify neonates with hearing loss. This can be achieved using OAE or ABR audiometry or both OAE and ABR in a two-staged program. Screening with OAE is a non-invasive, quick, simple, and safe method of detecting hearing loss in the neonatal period. Once hearing loss is identified, effective treatment options are available, which can secure holistic development of the child.

In this study, OAE alone was used for screening the neonates. The absence of OAE in both ears was taken as failed, whereas its presence in one or both ears was considered a pass. A referral rate of 8% for bilateral hearing loss was obtained in this study. This is similar to a study done in Shanghai, China, that reported a referral rate of 8%[10] using OAE. This is different from most TEOAE screening of other developing countries. Malaysia reported a referral rate of 12%,[11] South Africa 11.1%,[12] and Oman 11%.[13]

A preliminary finding in Nigeria by Olusanya *et al.* reported a referral rate of 18% using TOAE, although this was later reduced to 5% by ABR.[14] Similarly, Imam *et al.* reported 16% referral in well-baby nursery using TEOAE, which was reduced to 8% using ABR.[15] Benito-Orejas *et al.* reported a referral rate of 10.2%,[16] Pederson 11% and Helge in a two-tier screening process a referral rate of 5.18%[17] with TEOAE. Bielecki *et al.* reported a referral rate of 4.54% in Poland,[18] whereas Korres *et al.* reported a referral rate of 2.3% in well-baby nursery[19] with TEOAE.

The prevalence of permanent congenital hearing loss for developed countries was estimated to be 2–4 per 1000, whereas the postulated current global estimate for developing countries is 6 per 1000.[20] Tanon-Anoh *et al.* from Abidjan reported a prevalence of 6 per 1000,[21] and 2 per 1000[4] was reported in the New York state by the Universal Neonatal Hearing Screening (UNHS).

In this study, the prevalence of neonatal hearing loss is 80 per 1000 with a referral rate of 8%. This high prevalence of neonatal hearing loss may be attributable to the smaller number of population studied.

Unilateral hearing loss was considered normal in this study. The referral rate of unilateral hearing loss is 20%. Okhakhu *et al.* in Benin City reported the referral rate for unilateral hearing loss to be 16%,[4] which was similar to a study by Swanepoel *et al.* in South Africa.[12]

Out of the 12 neonates who failed the screening, the referral rate in females was 6.7% compared to 1.3% in males. This has a *P* value of .024, which is statistically significant. This is due to the fact that more females were recruited in the study compared to males. It is in contrast with the study from Qatar that reported referral rate of 2.7% in males and 2.5% in females.[22]

The independent risk factor that was found to be significant in this study is family history of hearing loss, which was similar to the study of Korres *et al.* who reported family history of hearing loss and congenital anomalies as important risk factors for hearing loss.[19] This differs from the findings of Olusanya[23] where hyperbilirubinemia was the independent risk factor for neonatal hearing loss. Pereira *et al*. in Sao Paulo[24] reported a gestational age of less than 30 weeks and birth weight of less than 1500 g to be important factors of failure rate. Srisuparp *et al.*[25] from Thailand reported craniofacial anomalies and mechanical ventilation greater than 5 days as significant risk factors for failure rate.

However, it is pertinent to mention that this study did not include high-risk neonates. Neonates with craniofacial anomalies, prematurity, and Special Care Baby Unit admissions were excluded in the study. Escobar *et al*.[26] and Elsanadiky and Afifi[27] both reported prematurity (with admission into neonatal intensive care) as the most important risk factor.

The risk factors of neonatal hearing loss vary from country to country, and these risk factors have been used for screening neonates in many countries worldwide. There is wide spread agreement that half of the hearing loss is due to genetic mutation. The high risk register (HRR) was initially used for neonatal hearing screening, which resulted in about 50% of neonatal hearing loss being undetected, thus the realization of universal neonatal hearing screening even among the well-baby nursery.

Conclusion

In conclusion, this study found high prevalence (8%) of failed TEOAE among full-term neonates delivered in our hospital. This failed TEOAE was more in female neonates compared to that in males. Family history of childhood hearing loss was identified to be a significant risk factor of failed TEOAE among these neonates.

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Conflicts of interest

There are no conflicts of interest.

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