ORIGINAL ARTICLE

Effects of Low Birth Weight Babies on Cochlear Function In Newborns at Dr Soetomo Hospital Surabaya

Wahyu Bagus Handokoa[1], Risa Etikaa[1], Agus Hariantoa[1], Nyilo Purnami[2]

[1] Neonatology Division Department of Child Health, Medical Faculty Airlangga University/Dr. Soetomo Hospital Surabaya, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota SBY, Jawa Timur 60132, Indonesia
[2] Otolaryngology, Head And Neck Surgery Department, Medical Faculty Airlangga University/Dr. Soetomo Hospital Surabaya, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota SBY, Jawa Timur 60132, Indonesia

ABSTRACT

Introduction: The prevalence of hearing loss ranges from 1 to 3 per 1000 live births and 2-4 per 100 high-risk babies as in low birth weight babies. Hearing screening in all newborns has not been fully implemented at Dr. Soetomo Hospital Surabaya so this research is expected to be the basis for hearing screening in all babies born especially low birth weight babies (LBW). The objective of the study was to predict the effect of low birth weight babies on impaired cochlear function in newborns. **Methods:** Cross-sectional comparative study was conducted from September 2018 to March 2019 in Dr. Soetomo Hospital. The subjects of this study were infants aged 2-28 days old in the nursery. Distortion Product Otoacoustic Emissions (DPOAE) was used to examineselected babies who fulfilled the selection criteria. **Results:** Twenty babies (≥2500 gram) and 20 babies (<2500 grams) were selected in this study. The proportion of cochlear dysfunction in infants with birth weights <1500 grams and 1500-2500 grams in Dr. Soetomo Hospital Surabaya was 50% and 35.7%. In multivariate analysis birth weight <1500 and birth weight 1500-2499 had a risk respectively 2.06 (95% Confidence Interval 0.08-48.26 P = 0.653) and 1.20 (95% Confidence Interval 0.07-20.34 P = 0.899) respectively. The proportion of cochlear dysfuntion in babies with birth weight ≥2500 grams is the highest which is 65 %. **Conclusion:** In this study Low Birth Weight Babies have a risk of 35.7 % of impaired cochlear function We would recommend DPOAE as screening method in all babies at Dr. Soetomo Hospital, Surabaya which is continued by second screening examination within one month on high risk babies and failed first test.

Keywords: Distortion Product Otoacoustic Emissions (DPOAE), low birth weight (LBW), cochlear function

Corresponding Author:
Risa Etika, PhD
Email: risaetika7797@gmail.com
Tel: +6231 5501695

INTRODUCTION

Impaired hearing function from birth can cause interference with aspects of speech, language, and cognitive development (1). Impaired hearing function in babies should be identified early so that early intervention is possible which benefits from the plasticity of the development of the sensory system (2). The prevalence of hearing loss is reported to range from 1 to 3 per 1000 live births. In high-risk babies (eg babies with low birth weight babies, perinatal asphyxia, hyperbilirubinemia) the estimated prevalence is around 2-4 per 100 babies (3,4). Many early detection programs in various countries are only based on specific risk factors. Selective screening results in 50% of children with hearing impairment not being detected so it is recommended to do universal hearing screening on all babies (5,6). So far, newborn hearing screening has not been carried out at Dr. Soetomo Hospital, Surabaya, so this research is the basis for hearing screening in all newborns, especially in babies with risk factors such as low birth weight babies (LBW).

An otoacoustic emission (OAE) is a fast and inexpensive screening tool. OAE can be used to assess the function of outer hair cells from the cochlea. A normal response to OAE is a strong predictor of normal hearing function. OAE does not require highly trained personnel and tests can be performed without the use of sedation in babies. With the availability of OAE as a screening tool, hearing screening programs in newborns become more efficient, effective, and reliable (7).

MATERIALS AND METHODS

This study was an observational analytic study with a cross-sectional comparative study design to analyze the effect of LBW on impaired newborn cochlear function. This research was carried out in the Neonatus Intermediate, Audiology Room in Dr. Soetomo Hospital Surabaya starting from September 2018 until March 2019. Low birth weight babies (LBW) are babies with birth weight less than 2500 grams and very low birth

weight (VLBW) are babies with birth weights of less than 1500 grams.

All newborns which met the inclusion criteria are admitted in this study. Inclusion criteria were: baby's parents agree to be included in the study (informed consent), age of baby 2-28 days, the baby is in stable condition. Exclusion Criteria were: OAE examination failed due to non-technical factors, the baby is using mechanical ventilation, weight less than 1000 grams. Subjects that met criteria were chosen randomly with consecutive sampling.

Each subject have to obtained the consent from a parent or guardian. The ethical clearance of this study was issued by the Health Research Ethics Committee, Dr. Soetomo Hospital, Surabaya No. 0601/KEPK/IX/2018. Before an OAE examination, the subjects were examined their ear canals by an otolaryngologists to make sure they were worth checking. Each subject of the study performed an OAE examination procedure in the form of an OAE device in the right or left ear. Checked using four frequencies namely 2000 Hz, 3000 Hz, 4000 Hz and 5000 Hz. OAE results in the form of a pass or refer can be read on the tool. OAE examination is conducted Neonatus Intermediate, Audiology Room Dr. Soetomo Hospital if the patient allows transport. If the patient cannot be transported the OAE examination is performed at the place where the baby is being treated. The inspection room must meet the noise standard <40 dB with measurements made using a sound level meter.

Microsoft Office Excel and IBM SPSS Statistic 21 were used to calculate the data. Descriptive analysis was conducted for presenting the characteristic demographic of subjects. Chi-Square Test, Logistic Regression, and Fisher Exact Test was used in order to obtained statistical value between variables and DPOAE.

RESULTS

Forty samples of babies aged 2-28 days were collected that met the inclusion criteria with 20 babies weighing over 2500 grams and 20 babies with birth weight less than 2500 grams. Data was collected in cross sectional way, the recording of LPD (Data Collection Sheets) was carried out by researchers and then DPOAE checks were carried out according to the research flow.

The characteristics demographic of the subjects are presented in Table I. The number of female subjects in this study was 27 (67.5%) compared to 13 male subjects (32.5%). The gestational age of the mothers of the study subjects is almost the same as premature pregnancies of 19 subjects (47.5%). Maternal age was divided into three categories with the number and percentage of each category: age less than 20 years by 2 subjects (5%), ages between 20 years and 35 years by 25 subjects (62.5%) and maternal age more than 35 years as many as 13 subjects (32.5%). The type of delivery was dominated by cesarean section with 36 subjects (90%). A total of 34 subjects (85%) were born to mothers with comorbidities with 6 of them (15%) taking medication during pregnancy.

Three subjects (7.5%) were obtained with low Apgar scores. Some subjects underwent treatment at the NICU more than 48 hours before as many as 17 (42.5%). In 13 subjects (23.5%) with birth weights less than 2500 gram, they had previously used oxygen. A total of 14 subjects experienced hyperbilirubinemia with the most occurrence in patients with birth weights less than 2500 gram. Only 6 subjects (15%) had previously experienced postpartum infections such as early onset sepsis. Six study subjects (15%) were exposed to previous ototoxic drugs such as the use of the antibiotic drug gentamicin. There were significant differences in the characteristics of the study subjects birth weight <2500 grams and birth weight ≥ 2500 grams on the variable gestational age (P <0.05), NICU care ≥ 48 hours (P <0.05), oxygen consumption (P <0.05), postpartum infection (P = 0.020), hyperbilirubinemia (P = 0.003) and the use of ototoxic drugs (P = 0.020).

Table I: Characteristics demographic of subjects

Variable	Birth Weight Category n (%)		Total n (%)	P
	<2500 gram	≥2500 gram		
Sex				1.000
Male	7 (35)	6 (30)	13 (32.5)	
Female	13 (65)	14 (70)	27 (67.5)	
Gestational age				0.000*
Premature	18 (90)	1 (5)	19 (47.5)	
Term	2 (10)	19 (95)	21 (52.5)	
Mothers age				0.591
<20 years	1 (5)	1 (5)	2 (5)	
20-35 years	11 (55)	14 (70)	25 (62.5)	
>35 years	8 (40)	5 (25)	13 (32.5)	
Type of Delivery				0.605
SVD (Spontaneous Vaginal Delivery)	3 (15)	1 (5)	4 (10)	
Sectio Caesarea	17 (85)	19 (95)	36 (90)	
Mothers disease				0.661
No	4 (20)	2 (10)	6 (15)	
Yes	16 (80)	18 (90)	34 (85)	
Drug during Pregnancy				0.182
No	19 (95)	15 (75)	34 (85)	
Yes	1 (5)	5 (25)	6 (15)	
Apgar Score	18 (90)	19 (95)	37 (92.5)	1.000
Normal	2 (10)	1 (5)	3 (7.5)	
Low				
NICU ≥ 48 hours	3 (15)	20 (100)	23 (57.5)	0.000*
No	17 (85)	0 (0)	17 (42.5)	
Yes				
Oxigen	7 (35)	20 (100)	27 (67.5)	0.000*
No	13 (65)	0 (0)	13 (23.5)	
Yes				
Post Partum Infection	14 (70)	20 (58.8)	34 (85)	0.020*
No	6 (30)	0 (0)	6 (15)	
Yes				
Hyperbilirubinemia	8 (40)	18 (90)	26 (65)	0.003*
No	12 (60)	2 (10)	14 (35)	
Yes				
Ototoxic drug	14 (70)	20 (100)	34 (85)	0.020*
No	6 (30)	0 (0)	6 (15)	
Yes				

Data are presented as number and percentage within rows and column
*a P value < 0.05 was considered statistically significants

Table II illustrated the DPOAE results for each frequency. In the majority of research subjects, referring to some low frequencies namely 2000 Hz and 3000 Hz. The number of cases of right and left ear DPOAE referred at a frequency of 2000 Hz from 40 research subjects were 16 (40%) and 15 (37.5%). The number of cases of right and left ear DPOAE referred at a frequency of 3000 Hz from 40 study subjects were 16 (37.5%) and 15 (45%).

Table II: DPOAE results for each frequency

	DPOAE Right Ears n (%)				DPOAE Left Ears n (%)			
	2000 Hz	3000 Hz	4000 Hz	5000 Hz	2000 Hz	3000 Hz	4000 Hz	5000 Hz
Refer	16 (40)	15 (37.5)	10 (25)	9 (22.5)	15 (37.5)	18 (45)	10 (25)	11 (27.5)
Pass	24 (60)	25 (62.5)	30 (75)	31 (77.5)	25 (62.5)	22 (55)	30 (75)	29 (72.5)

Data are presented as number and percentage

Table III showed the conclusions of DPOAE in both the right and left ears. In 13 cases (32.5%) the results of the DPOAE were referenced unilateral. And 8 cases (20%) obtained the results of DPOAE who refer bilaterally. Cumulative DPOAE in 40 study subjects found 21 cases (52.5%) who were referred.

Table III. Cumulative DPOAE Results

	DPOAE Right n (%)	DPOAE Left n (%)	DPOAE Unilateral n (%)	DPOAE Bilateral n (%)	DPOAE Cumulative n (%)
Refer	15 (37.5)	14 (35)	13 (32.5)	8 (20)	21 (52.5)
Pass	25 (62.5)	26 (65)	27 (67.5)	32 (80)	19 (47.5)

Data are presented as number and percentage

A description of DPOAE at frequencies of 2000 Hz, 3000 Hz, 4000 Hz and 5000 Hz for each body weight <2500 grams and ≥ 2500 grams can be seen in Figure 1. Most refer cases occur at low frequencies of 2000 Hz and 3000 Hz in both weight categories. The picture shows the frequency of DPOAE which often experiences refer especially at low frequencies of 2000 Hz and 3000 Hz. The number of passes and referrals in the right and left ears both at body weight <2500 grams and ≥ 2500 grams is almost the same.

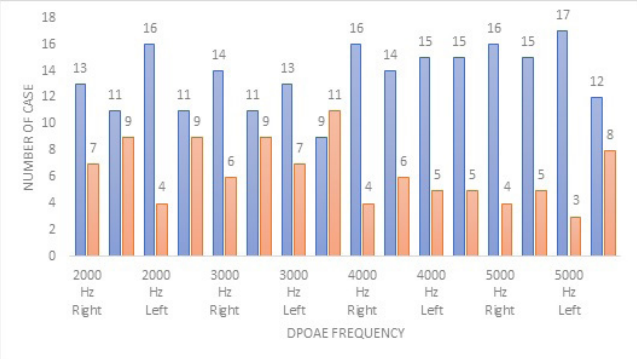

Figure 1: DPOAE examination results at each frequency and weight. A body weight <2500 grams B body weight ≥ 2500 grams.

In univariate analysis birth weight <1500 and birth weight 1500-2499 gram had risks respectively 0.54 (95% Confidence Interval 0.09-3.41 P = 0.511) and 0.30 (95% Confidence Interval 0.07 respectively -1.24 P = 0.098) (Table IV). In a multivariate analysis birth weight <1500 and birth weight 1500-2499 gram had risks respectively 2.06 (95% Confidence Interval 0.08-48.26 P = 0.653) and 1.20 (95% Confidence Interval 0.07-20.34 P = 0.899) (Table V).

Table IV: Univariate Analysis of Risk Factors for DPOAE Results

Variable	DPOAE		P	OR (95 % CI)
	Refer n (%)	Pass n (%)		
Sex[a]				
Female	15 (71.4)	12 (63.2)	0.826	1.46 (0.39-5.51)
Male	6 (28.6)	7 (36.8)		Control
Gestational Age[a]				
Premature	7 (33.3)	12 (63.2)	0.117	0.29 (0.08-1.07)
Term	14 (66.7)	7 (33.8)		Control
Mothers Age[b]				
<20 years	1 (4.7)	1 (5.3)	0.870	0.79 (0.04-14.03)
>35 years	6 (28.6)	7 (36.8)	0.565	0.67 (0.17-2.59)
20-35 years	14 (66.67)	11 (57.9)		Control
Type of Delivery[c]				
Caesarean Section	19 (90.5)	17 (89.5)	1.000	1.12 (0.14-8.82)
SVD	2 (9.5)	2 (10.5)		Control
Mothers Disease[c]				
Yes	20 (95.3)	14 (73.7)	0.085	7.14 (0.75-67.98)
No	1 (4.7)	5 (26.3)		Control
Drug during Pregnancy[c]				
Yes	4 (19)	2 (10.5)	0.664	2.00 (0.32-12.41)
No	17 (81)	17 (89.5)		Control
Birth Weight[b]				
<1500	3 (14.3)	3 (15.8)	0.511	0.54 (0.09-3.41)
1500-2499	5 (23.8)	9 (47.4)	0.098	0.30 (0.07-1.24)
≥ 2500	13 (61.9)	7 (36.8)		Control
Apgar Score[c]	2 (9.5)	1 (5.3)	1.000	1.89 (0.16-22.75)
Low	19 (90.5)	18 (94.7)		Control
Normal				
NICU ≥ 48 hours[a]	7 (33.3)	10 (52.6)	0.361	0.45 (0.13-1.62)
Yes	14 (66.7)	9 (47.4)		Control
No				
Oxygen [a]	6 (28.6)	7 (36.8)	0.826	0.69 (0.18-2.60)
Yes	15 (71.4)	12 (63.8)		Control
No				
Post Partum Infection[c]	3 (14.3)	3 (15.8)	1.000	0.89 (0.16-5.05)
Yes	18 (85.7)	16 (76.2)		Control
No				
Hyperbilirubinemia[a]	5 (23.8)	9 (47.4)	0.219	0.35 (0.09-1.34)
Yes	16 (76.2)	10 (52.6)		Control
No				
Ototoxic drug[c]	3 (14.3)	3 (15.8)	1.000	0.89 (0.16-5.05)
Yes	18 (85.7)	16 (76.2)		Control
No				

[a] analysis using Chi-Square Test, [b] analysis using logistic regression, [c] analysis using the Fisher Exact Test

Table V: Multivariate Analysis of Risk Factors for DPOAE Results

Variable	DPOAE		P	OR (95 % CI)
	Refer n (%)	Pass n (%)		
Birth Weight				
<1500	3 (14.3)	3 (15.8)	0.653	2.06 (0.08-48.26)
1500-<2500	5 (23.8)	9 (47.4)	0.899	1.20 (0.07-20.34)
≥ 2500	13 (61.9)	7 (36.8)		Control
Hiperbilirubinemia				
Yes	5 (23.8)	9 (47.4)	0.444	0.51 (0.09-2.82)
No	16 (76.2)	10 (52.6)		Control
Gestational Age				
Premature	7 (33.3)	12 (63.8)	0.394	0.32 (0.02-2.34)
Term	14 (66.7)	7 (36.8)		Control
Mothers Disease				
Yes	20 (95.3)	14 (73.7)	0,137	5.74 (0.57-57.61)
No	1 (4.7)	5 (26.3)		Control

Data was presented as number and percentage

DISCUSSION

The research lasted for 6 months to find out and analyze the relationship between low birth weight babies with hearing loss in newborns at Dr. Soetomo Regional Hospital, Surabaya. In this study there are differences in characteristics between research subjects with birth weight <2500 grams and ≥ 2500 grams. Significant differences were found in the variables of gestational age (P <0.05), NICU treatment ≥ 48 hours (P <0.05), oxygen consumption (P <0.05), postpartum infections (P = 0.020), hyperbilirubinemia (P = 0.003) and use ototoxic drugs (P = 0.020). In a study of newborn universal hearing screening conducted by Olusanya BO in 2005-2007 in Nigeria between 45 babies with very low birth weight (VLBW) (<1500 grams) and 225 babies with normal birth weight (≥2500 grams) found different characteristic differences significant in hyperbilirubinemia, neonatal sepsis and ototoxic drug use (8).

In this study the results of the pass and refer to the right and left ears both at body weight <2500 grams and ≥ 2500 grams are almost the same. There is literature which states that at the cochlea level, there is an asymmetry between the right and left ears where the OAE response is higher in the right ear (9).

This study uses four DPOAE f2 frequencies, namely 2000 Hz, 3000 Hz, 4000 Hz and 5000 Hz. The results of DPOAE in research subjects are more refer to low frequencies such as 2000 Hz and 3000 Hz. Research conducted using five DPOAE frequencies of 1000 Hz, 1500 Hz, 2000 Hz, 3000 Hz and 4000 Hz gives reliable results at frequencies above 1000 Hz. And premature babies give little response (10).

In univariate analysis birth weight <1500 gram and birth weight 1500-2499 gram have risks respectively 0.54 (95% Confidence Interval 0.09-3.41 P = 0.511) and 0.30 (95% Confidence Interval 0.07-1.24 P = 0.098). In multivariate analysis birth weight <1500 gram and birth weight 1500-2500 gram had a risk respectively 2.06 (95% Confidence Interval 0.08-48.26 P = 0.653) and 1.20 (95% Confidence Interval 0.07-20.34 P = 0.899). A study conducted in Thailand in 2010-2012 with univariate analysis obtained data on birth weight <1500 grams RR 4.3 95% Confidence Interval (2.3-8.1) P <0.001 and on birth weight 1500-2500 grams RR 2 0.95% Confidence Interval (1.3-3.0) P = 0.003. Multivariate analysis obtained data on birth weight <1500 grams RR 1.4; 95% Confidence Interval (0.7-2.8) P = 0.288 and on birth weight 1500-2500 grams RR 1.6; 95% Confidence Interval (1.1-2. =6) P = 0.029 (11).

The results of research in Turkey in 2009-2012 showed that 49 babies with birth weight <1500 grams, 13 (26.5%) of them had OAE refer compared to 2235 babies with birth weight> 1500 grams, 349 (15.6%) of them experiencing OAE refer with the result of Chi Square analysis P = 0.038 (12).

In a study conducted by Korres et al, of 19 babies with birth weights <1500 grams, 6 (31.6%) of them experienced a failure at first screening using Transient Evoked Otoacoustic Emission (TEOAE) (13). The prevalence of neonatal screening failure with very low birth weight is higher than the normal birth weight due to the accumulation of fluid in the middle ear so that conductive hearing loss occurs (14).

In this study ≥2500 grams babies has more cochlear dysfunction than the smaller babies. Many factors that affect the results of OAE such as gestational age, NICU treatment, oxygen consumption, postpartum infections, ototoxic drugs. The findings had shown the high % of failure rate in NICU babies especially the very low birth weight. Hence, we should think about doing a diagnostic hearing tests in this group of babies. for the other group, we may need to look at other factors that may contribute to the higher failure rate besides the weight. It is crucial to conclude the high % of failure rate needs urgent attention as need early diagnostic test. The high risk babies and failed first test should undergo second screening one month later. Babies who failed in hearing screening examinations should undergo early habilitation which may have benefits from the plasticity of the development of the sensory system.

Bias of this study was many confounding factors that affect the results of OAE such as gestational age, NICU treatment, oxygen consumption, postpartum infections, ototoxic drugs. In this study, we only analyze OAE as the first screening due to limited research funds, on subjects whose OAE results are refer, we recommend returning one month later to undergo a second screening. We hope next researchs are better with clearer and convincing report especially in a region where cost, logistic and community education are of concern.

CONCLUSION

Proportion of cochlear dysfunction in babies with birth weight <1500 grams in RSUD Dr. Soetomo Surabaya by 50%. And the proportion of cochlear dysfunction in babies with birth weight 1500-2500 grams in Dr. Soetomo Surabaya by 35.7%. In this study Low Birth Weight Babies have a risk of 35.7 % of impaired cochlear function but not statistically significant. Suggestions for future research include examination of OAE tests for referrals or all babies at risk at 1 month of age, advanced studies using a prospective cohort method with observations for 6 months, TORCH examination on subjects suspected of having a congenital infection, further studies to determine the relationship of other risk factors with hearing loss with a larger sample size. We would recommend DPOAE as screening method in all babies at Dr. Soetomo Hospital, Surabaya which is continued by second screening examination within one month on high risk babies and failed first test.

ACKNOWLEDGEMENTS

Authors would like to thank the Dean of Medical Faculty of Universitas Airlangga and Chairman of Dr. Soetomo General Hospital Surabaya for supporting this study. We also like to appreciate the help of Kinanti Ayu Ratnasari for editing and proof the manuscript.

REFERENCES

1. Yoshinaga-Itano C, Sedey A L, Coulter D K, and Mehl A L. Language of early- and later-identified children with hearing loss. Pediatrics. 1998;102(5):1161-71.
2. Yoshinaga-Itano C. Efficacy of early identification and early intervention. Semin. Hear. 1995;16(2):115-23.
3. Hyde M. L. Newborn hearing screening programs: Overview. J. Otolaryngol. 2006;34(2):70-8.
4. Davis A. A critical review of the role of neonatal hearing screening in the detection of congenital hearing impairment. Health Technol Assess. 1997;1(10):108-14.
5. Yoon P J, Price M, Gallagher K, Fleisher B E, and Messner A H. The need for long-term audiologic follow-up of neonatal intensive care unit (NICU) graduates. Int J Pediatr Otorhinolaryngol. 2003;67(4):353-7.
6. Busa J et al. Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. Pediatrics. 2007;120(4):898–921.
7. Kemp D T. Stimulated acoustic emissions from within the human auditory system. J. Acoust Soc Am. 1978;64(5)1386-91.
8. Olusanya B O. Perinatal profile of very low birthweight infants under a universal newborn hearing screening programme in a developing country: A case-control study. Dev Neurorehabil. 2010;13(3):156-63.
9. Ari-Even Roth D, Hildesheimer M, Roziner I, and Henkin Y. Evidence for a Right-Ear Advantage in Newborn Hearing Screening Results. Trends Hear. 2016;20:1-8
10. Gorga M P et al. Identification of neonatal hearing impairment: Distortion product otoacoustic emissions during the perinatal period. Ear Hear. 2000;21(5):400-24.
11. Poonual W, Navacharoen N, Kangsanarak J, and Namwongprom S. Risk factors for hearing loss in infants under universal hearing screening program in northern Thailand. J Multidiscip Healthc. 2015;9:1-5.
12. Karaca 3 T, Oysu 3, Toros S Z, Naiboğlu B, and Verim A. Is hearing loss in infants associated with risk factors? Evaluation of the frequency of risk factors. Clin Exp Otorhinolaryngol. 2014;7(4):260-3.
13. Korres S et al. Newborn hearing screening: Effectiveness, importance of high-risk factors, and characteristics of infants in the neonatal intensive care unit and well-baby nursery. Otol Neurotol. 2005;26(6):1186-90.
14. Manuscript A. NIH Public Access. 2014;27(4):1-19.