DISTORTION PRODUCT OTOACOUSTIC EMISSION ANALYSIS IN PREMATURE NEONATES

Análise das emissões otoacústicas evocadas por produto de distorção em neonatos prematuros

Jaqueline Batista Diniz[1], Sirley Alves da Silva Carvalho[2], Daniele Barreto Cunha Ferreira[3], Camila Vilaça Ramos[4], Iara Barreto Bassi[5], Luciana Macedo de Resende[6]

ABSTRACT

Purpose: to verify the incidence of changes in otoacoustic emission distortion product in premature infants and to analyze the magnitude of responses in relation to the gestational age in this population. **Methods:** observational cross-sectional study, which included results analysis of distortion product otoacoustic emissions of preterm newborns, screened in a public hospital in Belo Horizonte, from August 2010 to February, 2011. The infants were divided into three groups according to the gestational ages, the first group consisting of neonates aging 28-30 weeks, the second was of 31-33 weeks and third group of 34-36 weeks. This study was approved by the Ethics Committee of UFMG number 0210.0.203.000-10. **Results:** among the 44 children studied (93.62%) distortion product otoacoustic emissions (DPOAE) were present and only three children (6.38%) had absent DPOAEs. Regarding the amplitude analysis of the otoacoustic emissions and their comparisons between groups, no statistically significant difference was found between gestational groups, however we observed lower p values between gestational groups at high frequencies – 6kHz and 5KHz. **Conclusion**: prematurity in itself is not a factor that influences the outcome of DPOAE in premature neonates.

KEYWORDS: Otoacoustic Emissions, Spontaneous; Neonatal Screening; Hearing; Infant, Premature; Infant, Newborn

INTRODUCTION

One of the most common causes of stay in neonatal intensive care unit (ICU) is prematurity. As the majority of preterm neonates require special care in the ICU, sometimes during long periods, as for example, incubator permanence, use of ototoxic and permanence in mechanical ventilation, it can be considered that prematurity is a potential risk indicator for hearing impairments, especially for neonates that are small for the gestational age (SGA)[1, 2].

In addition, the patients of the Neonatal Intensive Care Units may present a greater number of middle ear diseases, which could affect the result of the Evoked Otoacoustic Emissions (EOAEs)[3].

Currently, it is known that evoked otoacoustic emissions have been applied as an ideal screening method. The otoacoustic emissions have three important clinical applications: identification of hearing loss through hearing screening; monitoring of cochlear function under adverse effects (drugs, noise, or degenerative processes); differential diagnosis and special applications (cochlear/retrocochlear diagnostic, special populations). The main

(1) Federal University of Minas Gerais – UFMG, Belo Horizonte, Minas Gerais, Brazil.

(2) Department of Speech Therapy of the Federal University of Minas Gerais – UFMG, Belo Horizonte, Minas Gerais, Brazil.

(3) Hospital das Clínicas (HC/UFMG), Belo Horizonte, Minas Gerais, Brazil.

(4) Hospital Sofia Feldman and Hospital João XXIII – FHEMIG, Belo Horizonte, Minas Gerais, Brazil.

(5) Federal University of Minas Gerais – UFMG, Belo Horizonte, Minas Gerais, Brazil.

(6) Department of Speech Therapy of the Federal University of Minas Gerais – UFMG, Belo Horizonte, Minas Gerais, Brazil.

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purpose of the otoacoustic emissions in neonatal screening is to early detect cochlear hearing loss in children, allowing the confirmation of the integrity of the mechanism of the outer hair cells of the cochlea[4-6].

The otoacoustic emissions can be directly influenced by the conditions of the external auditory meatus and "transmission properties" of the neonate[7]. Therefore, the possible influence of external factors during the use of OAE as a first hearing screening test, such as the influence of external noise present in the examination environment, the effects of vernix in the ear canal and the auditory canals collapsed during the first 24 hours of life[8], must be considered.

In the present research, the distortion product evoked otoacoustic emissions (DPOAEs) generated in response to two pure tone stimuli with moderate intensity (55-65 dB) and frequency ratio of f2/f1=1.22 were studied. More precisely, the DPOAEs occur from the simultaneous stimulation of two pure tones of different frequencies (f1 and f2). Such stimulation generates a cochlear response in the form of a third tone whose frequency (2f1-f2) constitutes a distortion product of the stimulus frequencies[7].

Prematurity may be a factor that influences the amplitude of response of the DPOAEs, since the cochlea of the premature neonate presents subtle immaturity of the function and the auditory system may present changes in the development until the completion of maturation[2-9].

In a study, three infants with lower gestational ages (28 to 30 weeks or less) were evaluated and they presented lower levels of response than the infants born after a longer gestational period[10].

Other studies report that distortion product otoacoustic emissions in neonates present higher amplitude due to the greater capacity of cochlear amplification and less saturation response in neonates compared with adults. However in preterm neonates, the saturation is higher when compared with term neonates and hearing-non-impaired adults, which supposes immaturity in cochlear amplification in these children[11].

The use of distortion product otoacoustic emissions is considered important since it covers a more specific analysis of the cochlear frequencies, which allows to check the possibility of non-maturation of cochlear frequencies coding in preterm neonates[2,11-12].

From this possible relationship between prematurity and hearing loss, the general purpose of this study was: to study distortion product otoacoustic emissions in preterm neonates. The specific purposes were: to verify the incidence of changes in the Distortion Product Otoacoustic Emissions in the population studied, to analyze the extent of the Distortion Product Otoacoustic Emissions as a function of the gestational age.

METHODS

This study was approved by the Research Ethics Committee of the UFMG under number 0210.0.203.000-10.

An observational cross-sectional study, which included the analysis of the results of the examination of distortion product otoacoustic emissions of preterm neonates evaluated in a public hospital in Belo Horizonte, was conducted from August 2010 to March, 2011.

The following criteria for inclusion were used: preterm neonates submitted to neonatal hearing screening whose parents and/or guardians have agreed to include the data from their examinations in the study by signing the informed consent form.

The neonates were randomly selected to participate in the research and all stayed at least one day in a neonatal intensive care.

During the period for the study, data of 47 preterm neonates whose age in the evaluation was defined as up to 90 days after birth were collected. The neonates were divided into three groups according to the gestational age, whereby the first group consisted of neonates aging 28-30 weeks, the second group of 31-33 weeks and the third group of 34-36 weeks.

The information regarding risk indicators, the results of DPOAEs and hospitalization time were taken from the medical records of the neonates before consent.

The infants were submitted to DPOAE record in quiet environment and remained in natural sleep or were awake without performing movements and/or sounds.

The equipment used was the otoacoustic emission analyzer of the Biologic® brand, model AuDX® plus, made in the USA. As DPOAE protocol, the frequencies 2kHz, 3kHz, 4kHz, 5kHz and 6KHz were tested with stimulation intensity: L1 equal to 65 dB and L2 equal to 55 dB and F2/F1 ratio equal to 1.22.

The responses with amplitude greater than or equal to 5dB and signal/noise relationship greater than or equal to 6dB were considered normal. The pass/fail criterion used was the observation of responses present in 4 of the 6 tested frequencies.

The statistical analysis of the data was performed using the SPSS (Statistical Package for the Social Sciences) version 17.0. First, a descriptive analysis of the data with measures of central tendency and dispersion was carried out, followed by test of variances equality. The method of analysis of

variance (ANOVA) was used to check the difference between the group averages. The results with p <0.05 were considered significant.

RESULTS

Forty seven neonates with ages up to 90 days after birth, 24 females and 23 males, were evaluated. Forty four (93.62%) of these children presented Distortion Product Otoacoustic Emissions (DPOAEs) and only three children (6.38%) presented absent responses.

In relation to the gestational age of the evaluated neonates, the minimum gestational age was 28 weeks and maximum 36 weeks and gestational age of 32.26 weeks in average.

The Tables 1 and 2 present the description of the amplitude of the DPOAE by gestational group as well as the comparative analysis. There was no statistically significant difference when comparing the gestational ages.

Table 1 – Amplitude of the distortion product otoacoustic emissions by gestational group concerning the right ear

	GA	N	Average	Standard Deviation	*P*
PD 2KHZ OD	28-30	12	3,93	10,55	
	31-33	15	5,96	7,12	0,330
	34-36	20	8,37	7,39	
	Total	47	6,46	8,24	
PD 3KHZ OD	28-30	12	6,79	8,10	
	31-33	15	2,88	8,66	0,339
	34-36	20	6,53	6,95	
	Total	47	5,43	8,08	
PD 4KHZ OD	28-30	12	7,32	13,61	
	31-33	15	11,40	7,12	0,237
	34-36	20	12,81	5,88	
	Total	47	10,96	8,89	
PD 5KHZ OD	28-30	12	8,02	11,64	
	31-33	15	8,29	10,77	0,128
	34-36	20	14,01	6,86	
	Total	47	10,65	9,78	
PD 6KHZ OD	28-30	9	3,88	10,38	
	31-33	14	11,38	6,66	0,053
	34-36	20	10,88	6,26	
	Total	43	9,58	7,80	

Anova p<0.05. Legend: GA: gestational age, PD: amplitude of the distortion product

Table 2 – Amplitude of the distortion product otoacoustic emissions by gestational group concerning the left ear

	GA	N	Average	Standard Deviation	*P*
PD 2KHZ OE	28-30	12	5,13	7,97	
	31-33	15	5,66	8,50	0,542
	34-36	20	8,01	7,53	
	Total	47	6,52	7,90	
PD 3KHZ OE	28-30	12	3,83	11,69	
	31-33	15	4,48	9,38	0,542
	34-36	20	7,05	5,99	
	Total	47	5,41	8,74	
PD 4KHZ OE	28-30	12	9,30	11,28	
	31-33	15	9,78	6,81	0,827
	34-36	20	11,13	8,49	
	Total	47	10,23	8,66	
PD 5KHZ OE	28-30	12	7,87	11,46	
	31-33	15	10,26	5,62	0,256
	34-36	20	12,84	7,69	
	Total	47	10,75	8,34	
PD 6KHZ OE	28-30	9	5,20	11,79	
	31-33	14	11,29	5,81	0,065
	34-36	20	12,81	7,02	
	Total	43	10,72	8,26	

Anova p<0.05. Legend: GA: gestational age, PD: amplitude of the distortion product

The Figures 1 and 2 show the results of the amplitude of the Distortion Product Otoacoustic Emissions of the frequencies analyzed in the different gestational groups studied for both ears.

DISCUSSION

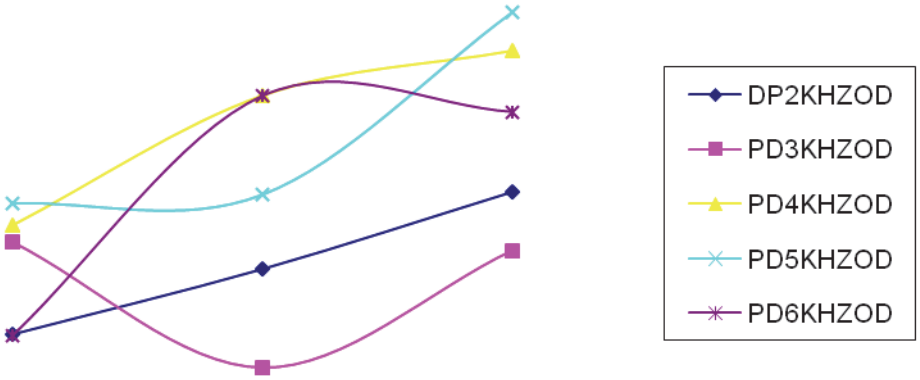
The study sample of 47 neonates can be considered homogeneous, since the number of newborns of both sexes was similar, being 24 (52%) females and 23 (48%) males.

Regarding the incidence of changes in the Distortion Product Otoacoustic Emissions in the studied population, no influence of the gestational age of the neonates was observed, because the three (6.38%) neonates who failed in the DPOAEs belonged to distinct gestational groups. Nevertheless, a study realized with the purpose to compare the latency of transient otoacoustic emissions (TOAEs) in at term and preterm newborns found statistically significant responses in the latency values between the tested groups, with higher values for the preterm group[13].

In a recent study, Melo et al.[14] evaluated 261 neonates between 24 and 54 hours of life and concluded that the result of the neonate who failed in the neonatal hearing screening is not related to the lifetime.

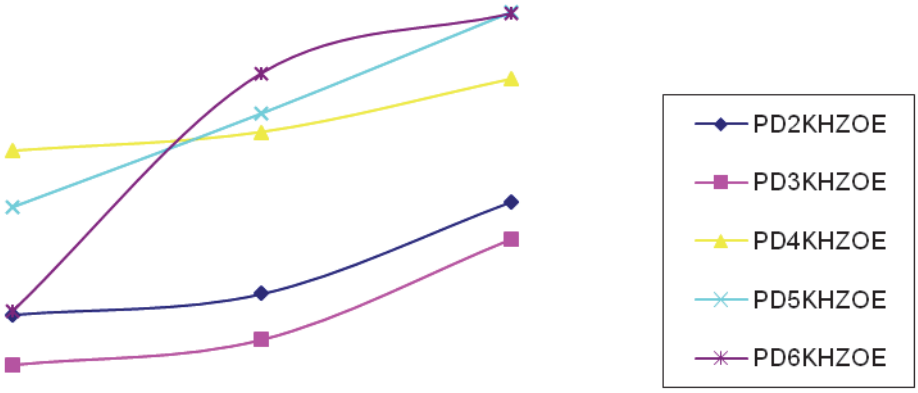
Of the neonates who presented absent DPOAEs, two (66.66%) belong to the gestational group of 31 to 33 weeks and only one (33.33%) belongs to the gestational group of 28-30 weeks. From this information it can be observed that the neonates that did not presented DPOAEs do not necessarily belong to the group of lower gestational ages (28 to 30 weeks). In the study of Melo et al[1], the authors argue the capacity of the human cochlea to present responses from the 27th week of life of the neonates, which could be observed in this study; although there were variations in the average of amplitude among the gestational groups, in the three groups analyzed, the neonates presented responses within the normal limits expected, with amplitude greater or equal to –5 dB.

Regarding the difference of amplitude of response between the ears, it was observed that in the three groups both ears showed agreement between the responses, without major differences in the variation of the average of amplitudes, which agrees with the studies of Pinto et al.[15], Melo et al.[1] and Raineri et al. [16].



Legend: DP: amplitude of the distortion product; OD: right ear

Figure 1 – Amplitude of the distortion product otoacoustic emissions in the right ear



Legend: DP: amplitude of the distortion product; OE: left ear.

Figure 2 – Amplitude of the distortion product otoacoustic emissions in the left ear

Although no statistically significant differences between the gestational groups have been found, smaller p values between the gestational groups at high frequencies – 5KHz and 6kHz were observed, which suggests a trend towards larger DPOAEs amplitudes at higher frequencies, corresponding to the function of the cochlea base. This corroborates the studies of Couto et al. [7] and Smurzynski et al. [5] that report that there is greater concentration of distortion product otoacoustic emissions at high frequencies and also that there is a greater tendency of the distortion product otoacoustic emissions to approach to normal values at higher frequencies.

The results of amplitude of the DPOAEs showed a non-linear growth of the amplitudes with the increase of the gestational age, suggesting smaller response amplitudes in infants with lower gestational age. In studies with at term and preterm neonates, Abdala[9, 11,17] suggests that the cochlea of the preterm neonate still presents subtle immaturities in the function and that it still goes through periods of maturation during the first months of postnatal life, becoming functionally mature between three and six months old [17].

Other analysis parameters of the OAEs have been suggested in addition to the analysis of the amplitudes, as the latency of responses, for example, that show significant differences in the preterm population.

CONCLUSION

In this study, it was observed that prematurity does not constitute a factor that influences the result of DPOAE in premature neonates. Most of the sample (93.6%) presented normal results to neonatal screening performed with the DPOAE.

The analysis of the amplitudes of the DPOAE in preterm neonates showed no differences related to the gestational age, although it constitutes a useful tool for understanding the cochlear maturity in these children.

RESUMO

Objetivos: verificar a incidência de alterações nas Emissões Otoacústicas por Produto de Distorção em neonatos prematuros e analisar a amplitude das respostas em função da idade gestacional nessa população. **Métodos:** trata-se de um estudo transversal observacional, que contou com análise dos resultados do exame de emissões otoacústicas evocadas por produto de distorção dos neonatos pré-termos, triados em um hospital público de Belo Horizonte, no período de agosto de 2010 a fevereiro de 2011. Os neonatos avaliados foram divididos em três grupos de acordo com a idade gestacional, sendo o primeiro grupo constituído por neonatos de 28-30 semanas, o segundo de 31-33 semanas e o terceiro grupo de 34-36 semanas. Este estudo foi aprovado pelo Comitê de Ética da UFG sob parecer número 0210.0.203.000-10. **Resultados:** dentre as crianças avaliadas 44 (93,62%) apresentaram Emissões Otoacústicas Por Produto de Distorção (EOAPD) presentes e apenas três crianças (6,38%) apresentaram EOAPD ausentes. Com relação à análise das amplitudes das EOAs e suas comparações entre os grupos estudados, não foi encontrada diferença estatisticamente significante entre os grupos gestacionais, entretanto observou-se valores menores de p entre os grupos gestacionais nas frequências altas – 5KHz e 6KHz. **Conclusão:** observou-se que a prematuridade em si não constitui um fator que influencia no resultado de EOAPD em neonatos prematuros.

DESCRITORES: Emissões Otoacústicas Espontâneas; Triagem Neonatal; Audição; Prematuro; Recém-Nascido

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Mailing address:
Sirley Alves da Silva Carvalho
Av. Prof. Alfredo Balena, 190/251 – Santa Efigênia
Belo Horizonte – MG – Brasil
CEP: 30130-100
E-mail: sicarvalho@medicina.ufmg.br