Objective: To evaluate the effects of perinatal asphyxia on the level of the response to transient otoacoustic emissions in infants.

Methods: Otoacoustic emissions in 154 neonates were performed: 54 infants who suffered asphyxia at birth, measured by Apgar score and medical diagnosis, and 100 infants without risk were compared. Scores less than 4 in the first minute and/or less than 6 in the fifth minute were considered as “low Apgar”. Statistical analysis of the data was performed using the Kruskal, Wilcoxon, and Mann-Whitney nonparametric tests.

Results: Lower levels of response were observed in transient otoacoustic emission in the group that suffered perinatal asphyxia, with significant values for the frequencies 2,000, 3,000, and 4,000 Hz in the right ear, and 2,000 and 4,000 Hz in the left ear.

Conclusions: The analysis of the intrinsic characteristics of the otoacoustic emissions evidenced low performance of outer hair cells in neonates who had perinatal asphyxia, which may affect the development of listening skills in this population.

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Introduction

The Apgar score allows for the evaluation of newborn clinical status and identification of those in need of assistance, assessing the risks of perinatal asphyxia. It consists of five criteria: heart rate, breathing effort, muscle tone, reflex irritability, and skin color. Each item is given values ranging from 0 to 2; the higher the score, the better the conditions at birth. This evaluation is performed by the neonatologist in the first, fifth, and tenth minute of life. However, perinatal asphyxia develops when there is significant tissue hypoperfusion and decreased oxygen supply, resulting from several etiologies in the peripartum period, which can cause neurological lesions and damage cochlear hair cells. Apgar scores lower than 4 in the first minute and/or less than 6 in the fifth minute are considered risk factors for hearing loss and deserve attention.

The first hearing assessment should be performed in the hospital nursery, using the otoacoustic emissions test for assessing the integrity of outer hair cells. In most studies on hearing screening with otoacoustic emissions, the criterion used to characterize a normal exam is based on the presence of response. However, for Aidan et al, one of the criteria to assess the actual status of the inner ear is the analysis of the intrinsic characteristics of this examination, such as the response magnitude of these emissions.

According to Basseto et al, full-term newborns have higher response amplitudes when compared to preterm newborns. The female gender and the right ear often have larger amplitudes. The use of ototoxic drugs can cause lower amplitude response for otoacoustic emissions. From the perspective that analysis of the signal/noise ratio can provide additional information on the operation of outer hair cells, this study aimed to evaluate the levels of response to otoacoustic emissions evoked by transient stimuli in infants who had perinatal asphyxia.

Methods

This study was approved by the Research Ethics Committee of Faculdade de Medicina de Botucatu (FMB) - Universidade Estadual Paulista (UNESP), process No. 4156/2012. Data were collected at the Center for Rehabilitation of Hearing and Communication Disorders (Centro de Reabilitação dos Distúrbios da Audição e Comunicação - CERDAC), Hospital das Clínicas (HC) FMB-UNESP, from April 2012 to April 2013.

The study consisted of a non-concurrent cohort with a fixed population. Inclusion criteria were: a) being born in the HC, b) presence of response in the otoacoustic emissions test, c) informed consent signed by the parents/guardians of the neonate. The exclusion criteria were: a) middle ear disorders diagnosed by the otorhinolaryngologist, b) presence of genetic syndromes, c) history of congenital infections, and d) use of ototoxic drugs.

For exposed individuals, an Apgar score of less than 4 in the first minute and/or less than 6 in the fifth minute was considered, as they are at risk for hearing loss, and this score was deemed “low Apgar”. The medical diagnosis of perinatal asphyxia for this group was also taken into account. The diagnosis of perinatal asphyxia was considered by the physician according to the clinical manifestations of the newborn, and was classified as neurological, cardiovascular, respiratory, metabolic, renal, gastrointestinal, or hematological. For those not exposed, only neonates with Apgar scores >7 in the first minute were selected for comparison.

There was no criterion for sample pairing, but potential confounders, gestational age, birth weight, and gender were tested (Tables 2, 3, and 4, respectively). As there was no evidence of significant probable associations with the outcome, the association between asphyxia and responses to otoacoustic emissions was analyzed without the need for correction.

Regarding the sample size calculation, since this was a non-concurrent cohort with a fixed population, no sampling dimension was required in the planning phase, but an estimate of test power, which ranged from 60% to 85%, depending on the frequency/ear. The power estimates considered a simple random sample, normality of outcomes, type I error of 0.05, and equal standard deviation between individuals with and without low Apgar.

The assessment of transient otoacoustic emissions was performed by a speech therapist specialized in audiol-
Assessment of levels of otoacoustic emission response in neonates with perinatal asphyxia

**Table 1** Sample characterization

| Variable       | n (%)       |
|---------------|-------------|
| Female        | 93 (60.4%)  |
| Male          | 61 (39.6%)  |
| GA (weeks)*   | 39 (37.4%)  |
| BW (grams)*   | 3.281 (2.170-4.610) |

* Summary in median, minimum, and maximum; GA, gestational age; BW, birth weight.

**Results**

The study included 154 infants; sample characterization regarding gender, mean gestational age, and birth weight is shown in Table 1.

Before the analysis of perinatal asphyxia effect on the response level of otoacoustic emissions, the effect of gestational age and birth weight as potential confounders was investigated, but no statistical significance was observed (Tables 2 and 3).

However, when investigating gender, higher response amplitudes were observed for females at 2,000 Hz, 3,000 Hz, and 4,000 Hz in the right ear, and 3,000 Hz in the left ear (Table 4).

When comparing infants who suffered perinatal asphyxia with those who were healthy, lower response amplitudes were observed in individuals exposed to the risk indicator for hearing loss in all frequencies, except at 3,000 Hz in the left ear (Table 5). In this case, the analysis was adjusted in relation to gender, as it was a potential confounding factor.

**Discussion**

One of the current methods to diagnose early hearing loss is hearing screening by otoacoustic emissions, which aims at identifying infants with possible hearing impairment. Its analysis is based on the categorization of responses as present or absent, but only those considered absent are candidates for diagnostic hearing evaluation by other methods, except in cases with suspected auditory neuropathy.

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Conflicts of interest

The authors declare to have no conflicts of interest.

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