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Research Article

Electrophysiological Threshold Evaluation in Infants with and Without Risk Indicators for Hearing Loss

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ARTICLE INFO

Article history:
Received: 16 December, 2019
Accepted: 27 December, 2019
Published: 3 January, 2020

Keywords:
Hearing loss
neonatal screening
auditory pathways
neonate
risk indicator

ABSTRACT

Introduction: The brainstem auditory evoked potential is used to determine the electrophysiological threshold and assessing the integrity of the auditory system. This test is sensitive to the auditory nerve maturation and brainstem; therefore, the electrophysiological threshold may change throughout child development.

Objective: to evaluate the changes in the electrophysilogical threshold of brainstem auditory evoked potential in two months of follow-up.

Methods: A single non-concurrent cohort study was performed in a public hospital during January 2013 to January 2015. The brainstem auditory evoked potential was performed in all neonates in two moments with electrophysiological thresholds measured in the both ears, whose results were categorized into degree: mild, moderate, severe and profound.

Results: Forty-three infants of both genders, 11 with prematurity and 14 with risk indicators for hearing loss participated in the study. In the first brainstem auditory evoked potential, with an average age of two months, 34 infants had abnormal results in the right ear and 31 in the left ear. In the second brainstem auditory evoked potential, with na average age of four months, normalization was observed in 38% of the results obtained in the right ear and in 42% on the left ear. This significant change in brainstem auditory evoked potential thresholds was found in those with mild and moderate degrees.

Conclusion: There were changes in the electrophysiological brainstem auditory evoked potential thresholds in infants with a mild and moderate degree, while those with a severe and profound degree the results were permanet at two months of follow-up.

Introduction

The gold-standard test used in the diagnosis of hearing loss in neonates is the brainstem auditory evoked potential (BAEP) [1]. It is an electrophysiological potential, with short latency, that appears in 10 to 12 ms after stimulus sound presentation. Its findings are sensitive to the auditory nerve maturation and brainstem, making it an useful instrument to follow the auditory pathway maturational process [1-3].

In the pediatric population, this test is used to estimate the hearing status, especially to determine the electrophysiological threshold and assessing the integrity of the auditory pathway [4, 5]. In neonates, the normal electrophysiological threshold is around at 30 dBnHL and it decreases with increasing age [3-5]. However, no responses to auditory tests or lack of sound reactions do not always define permanent hearing loss [6, 7].

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http://dx.doi.org/10.31487/j.JSR.2019.01.06

Another interesting aspect to be explained is that the peripheral portion of the auditory system is developed between the fifth and sixth month of gestation and the structures of the central portion continue to form synaptic connections and improve their efficiency during the first two years of life, so the electrophysiological threshold and wave latency may change during this period [8, 9]. In addition, variables such as: age, body temperature, middle ear effusion and hypoxic-ischemic lesions may cause transient changes in the test result [10-12]. Consequently, the preliminary findings of BAEP may not correspond to the final hearing status [1, 6, 7, 13]. The aim of the present study was to evaluate the changes in the electrophysilogical threshold of BAEP in two months of follow-up.

Materials and Methods

The study was approved by the Research Ethics Committee, protocol 402/08. Informed consent of parents was obtained for each subject before the study entry. It was a single non-concurrent cohort study conducted in a public hospital between January 2013 to January 2015, which met the following inclusion criteria: a) having performed BAEP in two moments; b) normal otorhinolaryngological evaluation before the exams; c) bilateral type A tympanometric curve with 1000 Hz probe tone.

I BAEP Technical Specifications

The EP15 - Eclipse Interacoustics ® / Denmark equipment was used in a silent room with the infant in natural sleep. The abrasive substance (Nuprep®) was used to clean the skin and the surface electrodes (Neuroline®) were fixed in different points, the active and ground were fixed to the forehead (Fz, Fpz) and the reference in the regions of the mastoid (M1 and M2). The stimulus was presented through the insertion phone ER 3A with monaural stimulation with filtered clicks (high pass band filter of 100 Hz and low pass filter of 2000 Hz), duration of 100 μs and rarefied polarity. A total of 2000 clicks with analysis time of 20 ms were provided, repeated to confirm the reproducibility of the waves. The impedance of the electrodes was always kept below 3 Kohms. The stimulus presentation rate was 27.7 clicks per second.

The initial intensity of the acoustic stimulus was 80 dBnHL for the neural integrity investigation and for electrophysiological threshold investigation, the intensity was decreased in steps of 20 dBnHL until the confirmation of the last intensity in which the V wave was visualized. In the absence of response, the intensity was increased in steps of 10dBnHL until the V wave was visualized always not exceeding the intensity of 100dBnHL. Normal hearing was determined by the presence of response on the conventional BAEP ≤ 30 dBnHL. The degree of hearing loss was categorized according to the threshold value of the BAEP threshold: mild (40 and 50 dBnHL), moderate (60 and 70 dBnHL), severe (80 and 90 dBnHL) and profound (> 90 dBnHL) [14, 15].

II Statistical Analysis

The McNemar test was used to compare the results of the first and the second BAEP in relation to the normality percentage. The odds ratio was used to compare BAEP according to the alteration degree in the first assessment. Relationships were considered statistically significant if $p < 0.05$. The program used was SPSS version 21.0.

Table 1: Characteristics of the patients.

Variables	n=43
Female/Male	17(40%)/26(60%)
Gestational age (weeks)[a]	36(26-41)
Birth weight (grams)[a]	2666 (815-4020)

[a] Average, minimum and maximum values.

Table 2: Normal percentage in the second BAEP in relation to the first BAEP, per ear.

	First BAEP results	Normal result in the second BAEP
Right Ear	Normal (n=9)	9 (100%)
	Abnormal (n=34)	13 (38%)
Left Ear	Normal (n=12)	12 (100%)
	Abnormal (n=31)	13 (42%)

p<0,001 (McNemar test). BAEP: brainstem auditory evoked potential.

Results

A total of 43 infants of both genders met the inclusion criteria. The characteristics of the patients is shown in (Table 1). In the sample, 11 (25.6%) infants were delivered preterm (< 37th gestational weeks), and 14 (33%) had at least one risk indicator for hearing loss: stay longer than five days in the ICU; Apgar less than four in the first minute of life; use of ototoxic medication; use of mechanical ventilation for more than five days and birth weight less than 1500g. In the first BAEP, infants had a mean age of two months. In the electrophysiological threshold research, it was observed that nine had normal and 34 abnormal results on the right ear, while 12 were normal and 31 abnormal results on the left ear (Table 2).

However, in the second BAEP, the infants had four months of life and your results showed a significant change. The electrophysiological threshold research showed that of the 34 infants initially abnormal on the right ear, 13 (38%) became with normal results, and 31 of the infants initially abnormal on the left ear, 13 (42%) became with normal results (Table 2). Regarding the degree of hearing loss, infants categorized as mild and moderate, in the first BAEP, had normal results in the second evaluation, however, those with a severe and profound degree maintained their results (Table 3).

Table 3: Normal percentage in the second BAEP in relation to the degree of hearing loss in the first BAEP, per ear.

	Degree of hearing loss	Normal result in the second BAEP	OR (CI 95%)
Right ear	Mild (21)	11 (52%)	1,00
	Moderate (6)	2 (33%)	0,45 (0,06-3,03)
	Severe/Profound (7)	0 (0%)	-
Left ear	Mild (19)	12 (63%)	1,00
	Moderate (3)	1 (33%)	0,29 (0,50-1,71)
	Severe/Profound (9)	0 (0%)	-

BAEP: brainstem auditory evoked potential. OR: odds ratio. CI: correlation index.

Discussion

The diagnosis and early treatment of hearing impairment are indispensable to reduce the impact on language development in children. The period considered proper for the intervention is around six months of age, so that those whose auditory thresholds are increased the rehabilitation by hearing aids or cochlear implant, is required as soon as possible [16, 17]. With the neonatal hearing screening programs implementation, younger children are referred for evaluation, and part of this population is comprised of preterm neonates and/or with risk indicators for hearing loss. Therefore, it becomes important to have knowledge of the maturational process interference and the clinical history in the audiological diagnosis, avoiding misinterpretations of the exams [11-13]. The first electrophysiological evaluation was performed with mean age of two months of life and the second with four months of life, in order to verify a possible change in the electrophysiological threshold and when necessary, the intervention occurred until the sixth month of life [16].

The hearing evaluation through the BAEP showed that most of the infants had a high electrophysiological threshold, but that this change was transient in 38% of the findings obtained on the right ear and in 42% of the ones obtained on the left ear and we emphasize that the middle ear changes were excluded by the ENT doctor and tympanometry. These thresholds recovery were also reported by other authors when they reported that the absence of response in the audiological evaluation does not represent a permanent hearing loss, since many factors may compromise the maturation of the auditory pathways or the ability to respond to a certain auditory threshold [18-20].What should also be considered is that the third trimester of gestation is extremely important for the auditory system maturation, since in this period of the cochlear myelinization begins between the cochlea and the brainstem [18, 19, 21]. Consequently, premature infants could have BAEP abnormal, however the changes observed in our study were in full-term and premature infants, regardless of gestational age.

Therefore, the electrophysiological record of the auditory function, both in latency and threshold research, is characterized by evolutionary parameters that must be taken into account during the analysis [22, 23]. Another aspect to be highlighted concerns the clinical history of the infant, since neonates with risk indicators are frequently referred for auditory evaluation and studies show reversibility in BAEP findings in cases of hyperbilirubinemia with transfusion levels, or in those auditory neuropathy [21, 22, 24]. However, there were no infants with these characteristics, but who showed changes between the exams.

Regarding the degree of hearing loss, for those with mild and moderate changes in both ears, the possibility of normalizing the results was statistically significant. This shows that the change in the auditory response does not always represent a permanent disorder and the interval between the evaluations allowed to observe the axonal growth maturation and the myelin sheaths and synapses formation, which allowed a less intense responses visualization in the second test [1, 7, 19, 22, 23]. The positive outcome found in these cases brings some relief to the evaluator, especially regarding the family feedback and the importance of exam retest. In contrast, infants with electrophysiological thresholds with severe and profound hearing loss were not change your hearing status, indicating the importance of immediate outcome, even in the prematurity and risk indicators for hearing loss occurrence.

Finally, this study showed that the number of cases identified as abnormal in the first test were not confirmed your status in the second test, and the auditory thresholds recovery was attributed to the maturational process and neonatal intercurrences. Therefore, continuous assessment of the auditory pathway in infants who had an abnormal BAEP result, as well as specific frequency tests, in cases of confirmed hearing loss are fundamental in the therapeutic decision.

Conclusion

There were changes in the electrophysiological BAEP thresholds in infants with a mild and moderate degree, while those with a severe and profound degree were permanent at two months of follow-up.

Conflicts of Interest

None.

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