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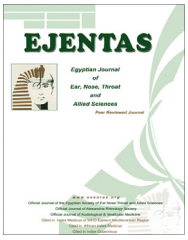

ORIGINAL ARTICLE

Study of reversibility of auditory brainstem abnormalities in infants with high risk for hearing loss

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KEYWORDS

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Abstract *Objectives:* This study aimed at assessing the reversibility of Brainstem Auditory Evoked Response (BAER) abnormalities in neonates; with risk factors such as hyperbilirubinemia or hypoxia after therapy.

Methodology: Two groups A and B consisting of 10 neonates with hyperbilirubinemia (term and preterm) and 10 hypoxic neonates (term and preterm) respectively, had their BAER initially recorded at an age of less than 1 month (as soon as they were discharged from the neonatal intensive care unit), and later at the age of 6 months. Criteria for diagnosing infants with hyperbilirubinemia or hypoxia were a serum bilirubin of >20 mg/dl and an Apgar score less than 6, respectively. A complete medical and family history was taken from the parents. Otoscopic examination, tympanometry, Transient evoked otoacoustic emissions (TEOAEs) were also done.

Results: All neonates (100%) had initial BAER abnormalities; thus fulfilling our selection criteria. BAER after 6 months showed significant improvements in both groups; 60% for group A and 55% for group B.

Conclusions: Serial BAER is a useful, noninvasive tool to detect neurodevelopmental delay secondary to neonatal hyperbilirubinemia and hypoxia.

1. Introduction

Significant hearing loss is one of the most frequent congenital diseases present at birth; it affects around 3 out of every 1000 live births and from 2 to 4 out of every 100 newborns leaving the neonatal intensive care unit.[1]

Children with hearing impairments are at significant risk for delayed speech and language and subsequently poor academic and social development; leading to a resulting burden on the society's costs for providing health and educational care for these children.[3,19,4,20,21]

Current guidelines include hearing screening for every newborn at no later than 1 month of age, especially for high risk (HR) infants, who sustain higher rates of hearing loss compared to normal infants.[1] Separate protocols of neonatal hearing screening based on ABR technology have been recommended.

A number of methods have been evaluated to search a reliable and effective technique for determining auditory functions

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in the neonates. ABR has expanded the possibility of objective testing of hearing functions. The latter is an effective and simple method that requires less co-operation of the patient and measures the specific part of the auditory pathway. It is not significantly altered by the state of consciousness, drugs and environmental factors like the sensory input to the cortex.[2]

Several test-related and subject-related factors can interfere with ABR recordings. Normal variables (e.g., age, body temperature) and pathological conditions (e.g., hearing loss and neurological disorders), can substantially influence the ABR.[2]

However, certain conditions such as middle ear effusion, minor hypoxic or ischemic lesions and central nervous system (CNS) immaturity, may have a transient course and may subside after a short period of time.[4] Consequently, ABR findings at the initial hearing screening of HR newborns may occasionally not correspond to the final hearing status.

Significant improvement or complete recovery of ABR thresholds in HR neonates treated for hyperbilirubinemia is probably the most characteristic example of ABR reversibility.[5,6]

Complete or partial restoration of ABR has been infrequently reported in HR infants[7] and pediatric patients suffering from a variety of medical conditions, such as hypoxia/ischemia,[8] metabolic[9] and neurologic diseases,[10,11] sudden idiopathic hearing loss[12] and meningitis.[13] The prevalence, however, of such findings has not been investigated so far.

The pathophysiologic mechanism of reversible sensorineural hearing loss has not yet been understood. A slow and lengthy period of CNS maturation may be responsible for ABR improvement or restoration to normal thresholds. Damaging factors with high prevalence among HR newborns can potentially lead to a retardation of the myelination process, expressed as immaturity or dysfunction.[14,17]

Regarding the previously mentioned, our study was designed to asses such temporary ABR abnormalities in term and preterm neonates with risk factors; in the form of hyperbilirubinemia or hypoxia.

2. Methods and materials

This study was carried out on 20 newborn infants (40 ears) discharged from the NICU of Al-Raml Children's Hospital in the time period between July 2012 and July 2013. A full informed consent from all infants' parents/guardians was taken before starting the study.

Infants were classified into 2 groups according to the risk factor;

1. Group A: Infants diagnosed with hyperbilirubinemia (serum bilirubin levels that exceeded 20 mg/dl).
2. Group B: Hypoxic infant (Apgar score less than 6).

Selection criteria included;

1. Less than 1 month of age.
2. No gender preference.
3. Type "A" tympanometry.
4. Initially absent or abnormal ABR.

Hearing assessment included complete history taking from the parents, otoscopic examination, tympanometry using 226 Hz probe, TEOAEs (in infants with absent ABR waveforms)[15] and auditory brainstem response measurement under natural sleep.

The Biologic System Corp Navigator Pro unit was used to do ABR measurements twice for all infants; an initial ABR during the first month of life and was later re-measured after 6 months to asses improvement.

For the ABR recording, patients were sleeping naturally in a quiet electrically shielded room. Threshold determination was carried out using 100 μs, rarefaction, broad band clicks, presented at a rate of 21.1/s, through inserted earphones, with a total of 2000 sweeps, with a time window of 15 ms. Electrode montage used was an ipsilateral montage with the positive recording electrode on the forehead, the negative recording electrode on the ipsilateral ear, and the ground electrode on the contralateral ear. ABR was recorded using a low pass filter with a cut-off frequency of 3000 Hz and a high pass filter with a cut-off frequency of 100 Hz.

A replicable waveform at 40 dBnHL within the expected latencies was considered as a "normal" or "pass" response. Any ABR threshold improvements, after 6 months, compared to initial readings were considered as a recovery.

3. Results

This study was carried out on 20 newborn infants (40 ears); 10 with a total serum bilirubin (TSB) exceeding a level of 20 mg/dl (Group A) and 10 with an Apgar score less than 6 (Group B). Demographic characteristics (Table 1) show that of the 20 infants, 12 were males (60%) and 8 were females (40%). The mean age (in days) of infants at the initial ABR was 20.8 ± 3.17 for group A, and 19.50 ± 5.07 for group B.

Table 2 shows ABR threshold measurements of the two groups; initially and 6 months later. A statistically significant improvement in thresholds was observed. Also, ABR threshold improvements were quantitatively estimated to be 60% improvement for group A and 55% improvement for group B (Table 3). Assessing improved measurements in a qualitative form was also done by comparing the number of present and absent ABR waveforms initially to those in the follow up 6 months later (Table 4). It was found that for group A, 10 ears had absent ABR waveforms whereas only 6 had absent waveforms 6 months later. Similarly for group B, 8 ears initially had absent ABR waveforms which were later reduced to 5 ears with absent waveforms in the follow up.

4. Discussion

The results of this study made it clear that a great part of ABR abnormalities initially detected in infants at risk for hearing loss has a reversible behavior.

Fulfilling our prerequisites, all 10 infants (20 ears) with hyperbilirubinemia (100%) initially had absent or abnormal ABRs; explained as 10 ears (50%) had absent ABR waveforms at 95 dBnHL, 5 ears (25%) showed severe hearing loss (threshold above 70 dBnHL) and another 5 ears (25%) showed moderate hearing loss (threshold of 50–60 dBnHL). Eight ears had absent ABR waveforms together with passed TEOAEs; suggesting an auditory neuropathy (AN) profile.

On follow up 6 months later, the majority of ears 12 (60%) displayed ABR improved thresholds. Total reversibility to