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Speech evoked auditory brainstem response findings in children with epilepsy

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ABSTRACT

Objectives: Children with epilepsy are at a considerable risk of cognitive impairment and school failure. Previous studies have typically documented abnormal responses in children with epilepsy at cortical level using speech stimuli. Recent studies reported that abnormal neural encoding of a speech syllable could be detected at the level of the brainstem using speech-evoked auditory brainstem response (ABR). The aim of this study is to investigate speech-evoked (ABR) results in children with epilepsy.
Methods: The study group consisted of 38 recently diagnosed epileptic children; none of them has received antiepileptic therapy. They were 22 males and 16 females with age 9.1 ± 3.1 years. The control group consisted of 38 healthy normal hearing children with matched age and gender distribution. All subjects underwent full history taking, basic audiologic evaluation including pure-tone, speech audiometry and immittance testing. Click ABR response was recorded monaurally from both ears at 90 dB nHL then speech ABR was recorded monaurally from each ear at 80 dB SPL.
Results: Though the study group disclosed normal click ABR compared to age matched normative values, speech-evoked ABR revealed a delayed waves V and A latencies in both ears. These findings reflect abnormal neural encoding of speech at the level of brainstem. The younger the age of epileptic child the more prolonged wave A latency and increased V/A inter-latency values.
Conclusions: Speech-evoked ABR results denote abnormal timing in the brainstem; such brainstem abnormality could be detected by speech evoked ABR rather than conventional click evoked ABR.

1. Introduction

Children with epilepsy are at a considerable risk of development of cognitive impairment and school failure. The risk factors for development of such cognitive impairment include; effects of chronic seizures on brain development, structure, and function [1–3], the medication used to treat seizures [4], and possibly the physiological disturbances that predisposed the brain to seizures in the first place [5]. Previous studies have documented influence of epileptic foci and the effect of medication on cognitive functions by using auditory event related responses; complex auditory stimuli such as speech were used to provide more insight of the brain processing in patients with epilepsy [6].

Brainstem encoding of complex sounds, such as speech stimuli, is important to uncover auditory processing deficits. Abnormal speech evoked ABR dose not only reveal auditory processing disorders at the brainstem level but it may point to cortical level disorders as well as brainstem and cortex level disorders are intimately linked [7,8]. Deficient brainstem timing to speech stimuli has been linked to several manifestations of abnormal cortical processing; Banai et al. [9] showed that asynchronous onset timing in the auditory brainstem was related to poor cortical sensitivity to acoustic change in a group of children with learning disability.

Theoretically, abnormal neural encoding to speech stimuli in epileptic children would be manifested at the level of the brainstem using speech-evoked ABR. So, the aim of this study was to investigate speech evoked ABR in those children and the pattern of abnormality (if any), which might have implications on their cognitive function.

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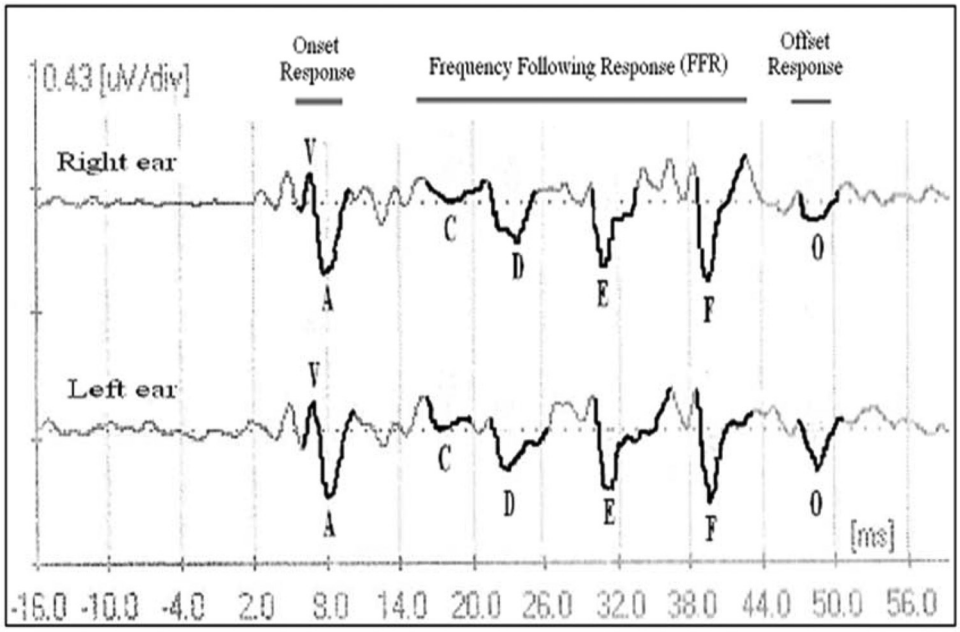

Fig. 1. Speech evoked ABR response registered from child with epilepsy. Each trace represents the summed response of two runs. The onset (V, A), FFR (C, D, E, and F) and offset responses (O) have all been highlighted. The onset responses (V, A) were delayed and beyond the mean + 2SD values of the control group.

2. Materials and methods

2.1. Subjects

This study was conducted in two tertiary referral centers, between March 2012 and January 2014 in Ain Shams University Hospital, Egypt and Hadi Clinic Hospital, Kuwait. The study group included 38 patients (22 males, 16 females) whose epilepsy was recently diagnosed and did not start antiepileptic therapy yet, their age ranged between 5 and 15 years (9.1 ± 3.1). The control group was matched to the study group; it included 38 healthy volunteers (22 males, 16 females), with age range 5–15 years (9.2 ± 3), and no neurological or otological symptoms. Informed consent was obtained from the parents of the children participating in this study, and the study was approved by the Ethical Committees at both centers participating in the study.

2.2. Methods

Detailed history was obtained from parents about the onset, duration and previous medication received. Neurological examination and EEG study was done for the study group. Pure-tone and speech audiometry was performed for all subjects using Madsen audiometer model Orbiter 922. The pure-tone thresholds were detected for octave frequencies (0.25–8.0 kHz). Immittancemetry including tympanometry and acoustic reflex threshold testing was performed using Madsen tympanometry model Zodiac 901. Audiological evaluation was done within 2 days of EEG testing, before commencing the antiepileptic therapy.

2.3. Click evoked ABR

ABR was registered using Bio-logic Navigator Pro, version 4.2 system. The stimuli, 100 μs rarefaction clicks, were presented at a rate of 21.1 Hz at 90 dB HL. The recording electrodes were silver chloride surface electrodes with impedance $<5\,k\Omega$. The active electrode placed centrally at (Cz) according to the 10–20 electrode system, the reference and ground electrodes at the ipsilateral and contralateral mastoid, respectively. Responses were band pass filtered from 100 to 3000 Hz, over 12 ms post-stimulus time period. Two runs of 1000 sweeps were averaged.

Identification of peak latency for waves I, III, and V was done, their absolute and interpeak latencies were used for further response analysis.

2.4. Speech evoked ABR

The speech stimuli used were 40 ms/da/stimuli; they were presented with alternating polarities to either ear at a stimulus rate of 10.9 Hz at 80 dB SPL. Responses were band pass filtered online from 100 to 2000 Hz and recorded over 60 ms post-stimulus time period. An artifact criterion of ±31 μV was applied to reject epochs that contained myogenic artifacts. Three thousand repetitions were collected for each stimulus polarity (condensation and rarefaction). Responses to each polarity of the/da/ stimulus were averaged separately and added together. Two runs were collected for each ear. The response to the onset of the speech stimulus/da/included a positive peak (wave V), followed immediately by a negative trough (wave A). Following the onset response, a series of negative peaks (C, D, E, and F) represented the frequency following response (FFR), offset response was represented by wave O. Peak latency for all waves and *V–A* slope were measured. Fig. 1 discloses speech evoked ABR response registered from child with epilepsy.

2.5. Statistical analysis

Student's *t*-test was used to compare the distribution of quantitative data when comparing the control and the study groups. While paired *t*-test was applied on comparing right to left ears within the same group. Chi square test was used to compare the distribution of qualitative data. The non-parametric Spearman's correlation test was used to detect statistical dependence between different variables. A "*p*" value of ≤ 0.05 indicated statistical significance. The computer program used was SPSS, release 18.0.