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Original article

Visual and brainstem auditory evoked potentials in children with obesity

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Abstract

Aims: The aim of our study is to investigate alterations in visual evoked potentials (VEP) and brainstem auditory evoked potentials (BAEP) in children with obesity.

Methods: A total of 96 children, with a mean age of 12.1 ± 2.0 years (range 9–17 years, 63 obese and 33 age and sex-matched control subjects) were included in the study. Laboratory tests were performed to detect insulin resistance (IR) and dyslipidemia. The latencies and amplitudes of VEP and BAEP were measured in healthy and obese subjects.

Results: The VEP P100, BAEP interpeak latency (IPL) I–III and IPL I–V averages of obese children were significantly longer than the control subjects. When the obese group was divided into two subgroups, those with IR and without IR, BAEP wave I, wave III and P100 wave latencies were found to be longer in the group with IR. A statistically significant correlation was observed between BAEP wave I latency, IPL I–V, IPL I–III and the homeostatic model assessment insulin resistance (HOMA IR) index and fasting insulin level.

Conclusions: Our findings suggest that VEP and BAEP can be used to determine early subclinical on auditory and visual functions of obese children with insulin resistance.

Keywords: Children; Obesity; Visual evoked potentials; Brainstem auditory evoked potentials

1. Introduction

The rapidly increasing prevalence of obesity among children is one of the most important problems facing pediatricians. The increased prevalence of childhood obesity has resulted in an increased prevalence of the comorbidities associated with obesity [1]. The comorbidities of obesity in childhood and adolescence include abnormalities in almost every organ system [2]. Insulin resistance and subsequent emergence of type 2 diabetes mellitus (T2DM) are the most important complications associated with obesity. The early onset of T2DM prompts a prior onset of morbidities, including

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nephropathy, retinopathy, and atherosclerotic cardiovascular disease [3] .

Visual evoked potential (VEP) is examining the visual pathway from the eye through the optic nerve to the occipital cortex [4]. VEP latencies measure the visual pathway of the cortical capacity while VEP amplitudes are identified with receptor reactions stimulated in retina and visual cortex [5]. Brainstem auditory evoked potentials (BAEP) measurements are valuable not only in the neurological assessment of brainstem function but also for detecting hearing problems in children. Impairment of neural activity is associated with sensory and cognitive information processing in obese children [6]. In addition, using the auditory brainstem response testing in pediatric patients with T1DM, the increase in the peripheral transmission time (wave I) was found to be associated with possible auditory neuropathy [7].

The aim of this study was to investigate the association between VEP/BAEP abnormalities and obesity in children.

2. Methods

A total of 63 children with obesity (35 female and 28 male) and 33 healthy children (19 female and 14 male), as the control group, were included. Children who had been admitted to pediatric endocrinology department for obesity evaluation were consecutively enrolled. Obesity was defined as BMI above the 95th percentile. Healthy controls were recruited from children with body mass index (BMI) between 10th and 85th percentiles, admitting to the outpatient department for various symptoms unrelated with obesity and its complications. A detailed physical examination including the evaluation of systemic and endocrine diseases were performed. All subjects were also examined by an otolaryngologist and ophthalmologist for related diseases. Assessment of pubertal development stage was performed by physical examination according to Tanner's criteria and categorized as prepubertal or pubertal. Prepubertal children and those with any systemic disease were excluded. Anthropometric measurements of the patients were performed by the same physician, while they were wearing light clothes and were barefooted. Weight measurement was performed by using a digital weighing scale (SECA 841, Hamburg, Germany) to the nearest 100 g and height was measured using a stadiometer to the nearest 0.1 cm. Body mass index was calculated as weight/height^2 and expressed as kg/m^2.

Fasting plasma glucose, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and serum triglyceride (TG) concentrations were measured enzymatically using an autoanalyzer (Olympus 2700, Olympus Medical Systems Corp., Tokyo, Japan). The Friedewald equation was used for calculating the low-density lipoprotein cholesterol (LDL-C) level. Fasting plasma insulin level measurement was performed by the ELISA method using an automated immunoassay analyzer (E170; Roche Diagnostics, USA). The IR was calculated by the formulation of homeostasis model of assessment (HOMA); fasting glucose (mg/dL) × fasting insulin (μIU/mL) × 0.055/22.5. The values >4 were described as positive IR [8]. Hyperinsulinism was defined as fasting plasma insulin values >15 μU/mL [9].

The VEP responses were recorded with Dantec Keypoint System (Medtronic Functional Diagnostics, Skovlunde, Denmark). During VEP response evolution, subjects were placed 100 cm from the monitor. Each eye was tested separately and with the opposite eye occluded. VEP responses were measured using checkerboard pattern reversal. Checkerboard pattern of black and white squares changing every 20 ms on the monitor were used as stimuli. A plus sign was located in the center of the monitor, as a visual image for the patients. Regarding VEP, the active electrode was placed onto the scalp in the midline over the occipital region 5 cm above the inion (Oz), the reference electrode was over the frontal region and the ground electrode was located on the forearm. The latencies and amplitudes of the P100 wave were evaluated.

The BAEP responses were recorded with Medelec Synergy 10 channel EMG device (Medelec Ltd, Oxford, UK). Electrodes were attached to vertex (Cz active electrode), the mastoid processes ($M_{1\text{-}2}$, reference electrode), and midline forehead (Fp_z, ground). The auditory stimuli were given at intensities up to 85 dB hearing level with earphone as click tone. For artefact rejection, two recordings were done for each ear and if the recordings repeated, they were considered as the potential. The responses were analyzed with a sweep time of 10 ms. Absolute latency for waves I, III, V and interpeak latency I–III, III–V and I–V were recorded. The latency derived from each ears were averaged to represent every patient by one value.

As descriptive statistics, number and percentage for categorical variables, and mean ± standard deviation values for continuous variables were used. To compare the obese and the control group for categorical variables, chi-square (χ^2) test was used, and to compare continuous variables the Student t test was performed. The mean values of each group were statistically analyzed using one-way analysis of variance (ANOVA) test. Two-group comparisons for significant values were performed using Tukey's post hoc test. The relationship between variables was evaluated by Pearson's correlation analysis. All analyses were performed with Statistical Package for the Social Sciences (SPSS) for Windows version 15.0, and the significance level adopted as $p < 0.05$.

An informed consent was obtained from each parents and the Institutional Review Board of GATA School of Medicine approved the study.