Research Article

Cortical Auditory Evoked Potentials (CAEPs) In Vestibular Migraine Patients

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Abstract

Introduction: Cortical auditory evoked potentials (CAEPs) are noninvasive measures used to quantify central auditory system function in humans. They represent series of positive and negative peaks labeled P١-N١-P٢-N٢ occurring between ٥٠and ٥٠٠ms after stimulus onset. The N١-P٢ complex was the first cortical auditory evoked potential (CAEP) to attract substantial research interest. P١ reflects the maturation of the auditory system in general as it has developed over time. **Objective**: The aim of this study was to assess the CAEP in vestibular migraine (VM) patients at different frequencies ٥٠٠, ١٠٠٠, ٢٠٠٠, ٤٠٠٠ Hz. **Methodology:** Sixty five subjects were studied with the CAEP, involving a control group and study group; the control group consisted of (١٥) subjects, the study group consisted of (٥٠) subjects with VM according to the diagnostic of c criteria ICHD-٣, ٢٠١٣. **Results:** (١) ANOVA test revealed no significant effect of frequency in the control group as regards the different CAEP parameters (N١ latency, P٢ latency and N١- P٢ amplitude). (٢) The independent sample median test comparing the control group and the VM group showed no statistical significant difference as regards CAEP parameters between the two groups at different frequencies. **Conclusion**s: The results suggest that patients with VM have no abnormality in different CAEP parameters at different frequencies compared to normal individuals.

Key words: Cortical auditory, evoked potentials, Migraine Patients

Introduction

Vestibular migraine (VM) is largely accepted in the vestibular community and represents the second most common cause of vertigo after benign positional vertigo and the most common cause of spontaneous episodic vertigo**,** by far exceeding Menière's disease (Neuhauser et al., ٢٠٠٦; Lempert and Neuhauser, ٢٠٠٩).

VM is diagnosed on the basis of the history and clinical information. The international Classification of Headache Disorder (ICHD-٣, ٢٠١٣) proposed diagnostic criteria for VM. These diagnostic criteria are: (١) at least five episodes of moderate or severe intensity vestibular symptoms, (٢) current or past history of migraine without aura or migraine with aura, (٣) at least ٥٠٪ of the episodes are associated with at least one of the three migrainous features: (a) headache with at least two of the following four characteristics: unilateral location, pulsating quality, moderate or severe intensity or aggravation by routine physical activity, (b) photophobia and/or phonophobia and (c) visual aura (٤) and the symptoms are not accounted by another vestibular disorder or another diagnosis listed in the international classification of headache disorder, ٣rd version.

Auditory manifestations were found in VM patients including tinnitus, phonophobia and hearing loss (Kayan and Hood, ١٩٨٤; Viirre and Baloh, ١٩٩٦). Moreover, peripheral and central auditory abnormalities were found in VM patients (Battista, ٢٠٠٤; Schoenen, ٢٠٠٦). These abnormalities were documented

through otoacousic emission (OAE), audiometry and auditory brain stem response (ABR) testing. It was postulated that vascular insults may be responsible for such auditory abnormalities (Viirre and Baloh, ١٩٩٦). However, the pathophysiology of auditory manifestations in VM is still incompletely delineated. For the best of our knowledge, results of Cortical auditory evoked potentials (CAEP) in VM patients were not reported in the literature. In the current study, the N١-P٢ CAEPs were recorded in VM patients.

CAEPs reflect obligatory neural events for speech representation in the central auditory system independently of the listener attention. The P١–N٢ complex has been suggested to be a representation of the sensory encoding of auditory stimulus characteristics (Weber et al., ٢٠١٣). One of the most important and clinically useful aspects of the CAEP is that in adults, the response can be observed close to threshold, and therefore can be used as an objective estimator of the auditory threshold (Tsui et al. ٢٠٠٢). The aided evoked cortical potential constituted a valuable tool for assessment of hearing aid benefit. It can introduce valid information about the frequency specific aided hearing thresholds for hearing aid or cochlear implant users (Hassan, ٢٠١٢). One of the advantages of the N١-P٢ response is the almost ideal frequency specificity it provides and testing the integrity of a greater proportion of the auditory nervous system and the capability to employ speech-based stimuli (Lightfoot and Kennedy, ٢٠٠٦).

Materials and methods

This was a prospective study involving a control group and study group; the control group consisted of (١٥) subjects were chosen to be age and sex matched with those in the study group. Age range between (٢٢) and (٤٤) years old. They were three males and ١٢ females. The study group consisted of (٥٠) subjects with VM according to the diagnostic criteria. Group of VM patients had mean age of (٣٥.٢) and age range between (٢٣) and (٥٥) years old. They were nine males and ٤١ females according to **ICHD-٣, ٢٠١٣**.

Subjects participated in the current study were examined after taking an oral consent following detailed explanation of the study procedure. The study was approved by the research ethical committee in Minia University.

All subjects in the current work were examined by CAEP using IHS two channels evoked potentials apparatus with the smart EPs software version ٤.٥ During recording, subjects were instructed to read a magazine or a book of their interest, stay alert during the testing and minimize eye blinking. Electrodes were placed at the following sites: active electrode in the vertex (Cz), negative one in each mastoid and the ground electrode was placed on the forehead. The response was recorded ipsilaterally to the ear stimulated. The stimuli were ٥٠٠ Hz, ١٠٠٠ Hz, ٢٠٠٠ Hz and ٤٠٠٠ Hz tone bursts. The rise- fall time was ٢٠ msec. and the plateau was ٢٠ msec. The stimuli were delivered through TDH ٣٩ headphone. The stimuli were delivered at a rate of ٠.٥ and the stimulus level was ٧٠ dB nHL. The response was band passed between ١ and ١٥ Hz, amplified (٢٥٠٠٠) times and recorded over time window of ٥٦٠ m sec. including ٦٠ m sec pre stimulus base time. The number of sweeps was ١٠٠ or less. Recording was stopped once a reliable response obtained at each stimulus to avoid adaptation of the response. The response was considered a cortical response if it was repeatable and had the appropriate wave form, amplitude and latency. The analyzed response was N١- P٢ amplitude and latencies of P١, N١ and P٢. Figure (١) shows an example of CAEP from one of the control group.

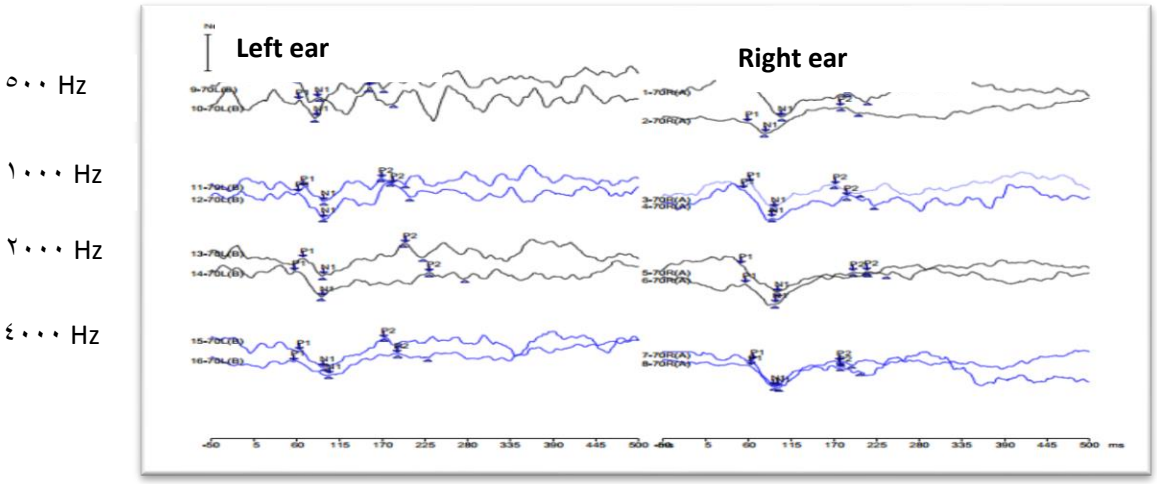

Figure ١: Cortical auditory evoked potentials (CAEP) testing from both ears of one of the control group using ٥٠٠. ١٠٠٠, ٢٠٠٠ and ٤٠٠٠ Hz tone burst at ٧٠ dB nHL .

Results

ANOVA test revealed no significant effect of frequency in the control group as regards the different CAEP parameters (N١ latency, P٢ latency and N١- P٢ amplitude)

Table ١: ANOVA test for frequency effect on the CAEP parameters (N١ latencies, P٢ latencies and N١- P٢ amplitude)

Value	N١ latencies	P٢ latencies	N١- P٢ cortical amplitude
P value	٠.٧٥٤	٠.٨٠٩	٠.٦٥٢

Table ٢-٤ show minimum, maximum, mean, standard deviation and The independent sample median test comparing the control group and the VM group as regards the different CAEP parameters (N١ latencies, P٢ latencies and N١- P٢ amplitude) at the different frequencies. There was no statistical significant difference as regards CAEP parameters between the two groups at different frequencies.

Table ٢: Comparison between the control group and the VM group as regards N١ latency; in addition to the independent sample median test.

N١ latencies in msec. at ٥٠٠ Hz	Min.	Max.	Mean ± SD	Median	P. value
Control group	٦٧.٥	١١١.٢	٨٨.٩ ± ١٠.٨	٨٦.٧	
VM group	٦٠	١٢٠	٩٢.٩ ± ١٣.٢	٩٢	.١٤٩
N١ latencies at ١٠٠٠ Hz					
control group	٧٥	١١٢	٩٠.٩ ± ١٠	٩١.٢	
VM group	٧١	١٣١	٩٥.٤ ± ١١.٢	٩٥	٠.١٧٧
N١ latencies at ٢٠٠٠ Hz					
Control group	٦٨.٥	١١٢	٨٧.٢ ± ١٢.٩	٨٩	
VM group	٧١	١٢٨	٩٤.٥ ± ١٢.٣	٩٥	٠.٤٣٢
N١ latencies at ٤٠٠٠ Hz					
Control group	٧٢	١٤٢	٩٣.٦ ± ١٦.٢	٩٤	
VM group	٦٤	١٣٥	٩٦.١ ± ١٦.٦	٩٣	٠.٨٨٩

Table ٣: Comparison between the control group and the VM group as regards P٢ latency; in addition to the independent sample median test.

P٢ latencies in msec. at ٥٠٠ Hz	Min.	Max.	Mean ± SD	Median	P. value
Control group	١١٦	١٨٥	١٥٦.٢ ± ١٩.٣	١٥٤.٨	٠.٩٧٥
VM group	١٣٥	٢١٩	١٦٧.٥ ± ٢١.٦	١٦٤	
P٢ latencies at ١٠٠٠ Hz					
control group	١١٤	١٧٦.٨	١٥٢.٦± ١٧.٩	١٥٤.٨	٠.٠٤٧ NB
VM group	١٣٦.٨	٢٣٢	١٧١.١ ± ٢١	١٦٩.٦	
P٢ latencies at ٢٠٠٠ Hz					
Control group	١٠٨.٥	٢٠٠	١٥٩ ± ٢٦.٩	١٦٠.٨	٠.٣٩٥
VM group	١٢٤	٢٣٨	١٦٨ ± ٢٣.٨	١٦٥	
P٢ latencies at ٤٠٠٠ Hz					
Control group	١١٢	١٩٣	١٥٩.٣ ± ٢٣.٤	١٦٤.٤	٠.٩٧٥
VM group	١٢٣	٢١٦	١٦٨.١ ± ٢٠.٦	١٦٨	

Table ٤: Comparison between the control group and the VM group as regards N١- P٢ amplitude; in addition to the independent sample median test.

N١- P٢ CA in µv at ٥٠٠ Hz	Min.	Max.	Mean ± SD	Median	P. value
Control group	٣.٧	١٨.٤	٩.٧ ± ٤.٧	٩.٩	٠.٧٩٥
VM group	١.٦	١٥.٥	٨.٣ ± ٣.٤	٧.٨	
N١- P٢ CA in µv at ١٠٠٠ Hz					
control group	٦	١٦.٥	٩.٢ ± ٢.٧	٨.٤	.٧٧٨
VM group	١.٧	٣١.٤	٩.٢ ± ٥.٤	٨.٧	
N١- P٢ CA in µv at ٢٠٠٠ Hz					
Control group	٤.٢	٣٧.٤	١٠.٨ ± ٨.٩	٧.٦	.٦٨٢
VM group	١.٧	١٧.٦	٨.٨ ± ٤	٧.٩	
N١- P٢ CA at ٤٠٠٠ Hz					
Control group	٢	٢١.٢	٩.٦ ± ٥.١	٨.٦	.٨٣٩
VM group	١.٦	٢٨.٤	٩.٦ ± ٥.٦	٩	

Discussion

The N١-P٢ CAEP is a valuable but underused tool in the audiologist's armory. It is most useful in cases of adults and older children unable or unwilling to perform accurate pure tone audiometry. It is less affected by muscle activity and is more frequency-specific than the auditory brainstem response. Disadvantages include poorer precision of threshold estimation in infants and younger children and the lack of time-efficient software and objective CAEP detection in mainstream auditory evoked potential systems.

The main focus of this work was to compare different CAEP parameters (N١ latencies, P٢ latencies and N١- P٢ amplitude) at the different frequencies between VM patients and the normal individuals.

VM patients are more sensitive to numerous unpleasant sensory inputs and these inputs trigger a threshold which causes a cortical event followed by a brainstem event causing more input to be perceived as noxious resulting in headache. Thus, the brain of VM patients is hyper excitable. The cortical spreading depression may play a role in patients who are having short attacks. Calcitonin gene related peptide, serotonin, adrenaline, and dopamine involved in the pathogenesis of migraine also modulate the activity of a number of central and peripheral vestibular neurons thus contributing to the pathogenesis of vestibular migraine (Fasold et al., ٢٠٠٢).The unilateral release of these substances causes one-sided headache and a static vestibular imbalance resulting in rotatory vertigo. Bilateral release of these substances could result in motion sickness type of dizziness. Episodic vertigo has been associated with certain genetic syndromes. Otologic symptoms such as phonophobia and hyperacusis seen in migraine patients might be related to stress induced headache (Karadag et al., ٢٠١٥).

In the current work, There was no statistical significant difference as regards CAEP parameters between the two groups at different frequencies. Several researches done on the effect of VM on ABR but results of cortical auditory evoked potentials (CAEP) in VM patients were not reported in the literature. John et al., (٢٠١٦) found a larger proportion of patients (٢٦ patients out of ٣٠) had abnormal values in either ABR absolute latency or IPL in one or both ears but overall, cases had shorter latencies than controls. One study (Hamed and Elattar, ٢٠١٢) done on migraine patients reported ٢٨٪ patients having one or more ABR abnormalities in the form of prolonged absolute latency of Wave III and I-V IPL. Kochar et al., (٢٠٠٢) reported significant prolongation in absolute and IPLs at the time of acute attack of migraine. These disappeared after ٧ days from the attack indicating reversible pathological changes in different areas of the brain and brainstem. Some authors reported prolonged absolute latency of Wave V and I-V IPL during the headache attack indicating transient impair-ment of the auditory brainstem function. None of our patients had acute attack of migraine or vertigo at the time of ABR testing. This audiological finding is similar to those found on vestibular tests in VM, though central vestibular signs have been reported during acute episodes. The frequency of migraine attacks and the duration of illness were identified as important confounders associated with BERA abnormalities (Hamed and Elattar, ٢٠١٢).

Conclusions

VM is a frequent disorder. Associated symptoms as hearing loss, tinnitus, phono-phobia, and photophobia and motion intolerance are common in VM. The auditory cortical pathway seems to be unaffected during the interictal phase in VM.

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