Original Article

Role Of Ocular Vestibular Myogenic Potential In Prediction Of Outcome In Idiopathic Intracranial Hypertension

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Abstract

Background Idiopathic intracranial hypertension (IIH) is characterized by an increase in intracranial pressure (ICP). The present work aimed to assess ability of ocular vestibular evoked myogenic potentials (oVEMP) in evaluating the extent of clinical and subclinical impairment of the central nervous system in patients with Idiopathic Intracranial Hypertension (IIH), and clinical outcome after cerebrospinal fluid (CSF) tapping.
Methods A Prospective human study was carried out on forty female patients with IIH aged from 18 to 60 years between 2019 and 2021. They were subjected to clinical assessment, ocular vestibular myogenic potential before and after therapeutic CSF tapping at Neuro-Diagnostic &Research Center (NDRC), Beni-Suef University Hospital. Forty age and sex matched normal volunteers were also included as a control group.
Results Patients with (IIH) after CSF tapping showed There was significant increase of the N1-P1 amplitude of oVEMP from 3.4 (1.9) to 3.9 (2.3) µV with (P=0.012). However, after CSF tapping, when compared patients to controls, the oVEMP amplitude in patients did not reach the controls values 3.9 (2.3) to 6.6 (3.8) µV with (P=0.001).
Conclusion The amplitude of oVEMP is the most sensitive parameter to detect improvement in IIH after therapeutic CSF tapping.

Keywords Idiopathic Intracranial Hypertension, Therapeutic CSF tapping, and Ocular vestibular myogenic potential

Introduction

Idiopathic intracranial hypertension is a syndrome characterized by an increase in ICP in absence of space occupying lesion or dilated ventricles and with normal CSF biochemical composition, it usually occurs in obese women in the childbearing years **[1]**.
The pathophysiology of IIH is still under research, however, excessive CSF production by the choroid plexus, impaired CSF absorption by the arachnoid granulations, and changes in the central venous pressure may be possible causes of increased intracranial pressure. The etiology of IIH is more likely related to an increased resistance to CSF outflow **[2]**.
A plenty of published research showed that Estrogen and endogenous retinoids (vitamin A) may contribute to increased CSF outflow resistance. Genetic factors may also play a role **[3]**.
The main symptoms of the IIH are headache (76-94%), transient visual obscurations (68-72%), pulse synchronous tinnitus (52-61%), photopsia (54%), and retrobulbar pain (44%). Diplopia (38%) and visual loss (30%) are the least common accompaniments of IIH **[4, 5]**.
Ocular vestibular evoked myogenic potentials (oVEMP) are an electrodiagnostic short latency myogenic potentials likethe vestibulo-ocular reflex evoked by vestibular stimulation. Otolithic afferent neurons activate electromyographic activity of the extra ocular muscles and can be recorded contralateral to the stimulated ear thorough surface electrodes under the eye **[6, 7]**.

Methods

A Prospective human study was carried out on forty female patients with IIH aged from 18 to 60 years, between 2019 and 2021 recruited from Neurology Outpatient Clinics, Beni Suef University Hospital. IIH was diagnosed according to modified dandy criteria in 1985 that include symptoms of raised intracranial pressure (headache, nausea, vomiting, transient visual obscurations, or papilledema) without localizing signs except abducent (sixth) nerve palsy; LP opening pressure of more than 200 mmH2O, in the non-obese and probably greater than 250 mmH_2O in the obese patients; normal biochemical and cytological composition of CSF, and normal CT/MRI findings without evidence of thrombosis. These patients were compared with forty-age and sex matched normal volunteers recruited specifically for the study. We excluded patients with old or recent cranial nerves palsies, symptom or signs suggesting increased ICP (e.g., cerebral tumors), brainstem lesions, cerebrovascular disease, systemic and medical diseases causing cranial neuropathy e.g., diabetes mellitus, hepatic or renal failure, toxic exposures.

All IIH patients under research before and after therapeutic CSF tapping were subjected to:
History taking about disease duration, medication and presence of manifestation of increased intracranial pressure: headache, blurring of vision, vomiting, tinnitus and transient visual obscurations; general and neurological examination; Cranial nerves examination; Routine laboratory work-up including: complete blood count, INR, liver function and renal function tests; Fundus Examination and assessment of the degree of papilledema and Therapeutic CSF drainage was carried out for lowering ICP with analysis of its biochemical components and opening pressure.
Neurophysiological studies was carried out in the Neuro-Diagnostic &Research Center (NDRC), Beni-Suef University Hospital using Nihon Kohden EMG/EP ® apparatus.

Air-conducted Ocular Vestibular evoked myogenic potential (oVEMP) was performed thorough monoaurally stimulation by a headphone and recording by surface electrodes at the midpoint of the lower eye lid contralateral to the stimulated ear. N1 (N10) latency was measured from the first negative peak and P1 (P15) from the first positive peak, the VEMP amplitude was identified as N1-P1. Each response was average from 50-100 times.

Conditions

The sweep speed was set at 10 msec per division. Initial sensitivity was 500 microvolts; the filter settings were 10 Hz for the high cut off filter, 1 KHz for the low cut off and the notch filter at 50 Hz.

Statistical Analysis

Data were statistically described in terms of mean, and SD for quantitative variables, while numbers (No.) and percent's (%) was used for qualitative variables. Independent T-test was used to detect the difference between cases and controls regarding scale variables. Chi-Square test was used to detect the difference between both groups regarding the categorical variables. A probability value (P) less than 0.05 was considered statistically significant. Analysis of data was performed using SPSS v. 25 (Statistical Package for Social science) for Microsoft Windows.

Results

The demographic data of patients and controls are illustrated in **Tables 1**.

Table (1) Age and body mass index of the studied groups

Items	Patients (mean±SD)	Controls (mean±SD)	P-value
Age	35.4±10.5	33.8±8.9	0.508
BMI	26.7±1.5488	26±2.2	0.237

The clinical data are summarized in **Table 2.**
The mean disease duration was 17.3±22.4 weeks. The mean opening pressure was 294±24.6. There were 3 patients presented with grade I papilledema (15%), 13 patients with grade II (65%) and 4 patients with grade III (20%)

Table (2) Clinical data of the studied patients

Items	Patients
Disease duration (weeks)	17.3±22.4
Opening pressure	294±24.6
Papilledema Grade I Grade II Grade III	 3 (15%) 13 (65%) 4 (20%)

We compared oVEMP data of patients before the lumbar puncture (LP) and two weeks after that. There was a significant increase of the N1-P1 amplitude from 3.4 (1.9) to 3.9 (2.3) µV with (P=0.012) (**Table 3)**. Also, we compared data of patients after LP and controls, we found that there was still significant decrease of the oVEMP amplitude in patients than controls from 3.9 µV (2.3) to 6.6 µV (3.8) with (P=0.001) **(Table 4)**.

Table (3) Effect of lumbar puncture on the oVEMP parameters

oVEMP Parameters		Mean±SD	P-value
N1 Latency (milliseconds)	Before	10.8±1	0.759
	After	10.7±0.7	
P1 Latency (milliseconds)	Before	15.2±1.2	0.532
	After	15.1±0.7	
N1-P1 Amplitude (µV)	Before	3.4±1.9	0.012
	After	3.9±2.3	

Table (4) Comparison between patients (after the intervention) and normal healthy controls regarding oVEMP parameters

oVEMP Parameters	Patients	Controls	P-value
N1 Latency (milliseconds)	10.7±0.7	10.6±0.6	0.469
P1 Latency (milliseconds)	15.1±0.7	15.2±0.7	0.250
N1-P1 Amplitude (µV)	3.9±2.3	6.6±3.8	0.001

Table 5 show a significant negative correlation between {P1 latency and patient's age (r= -.321, P= 0.046); N1-P1 amplitude and BMI (r= -.653, P= 0.000) and N1 latency and duration of illness (r= -.311, P = 0.054)}.

Table (5) Correlation between oVEMP parameters to age, BMI and duration of illness of patients with IIH

		Age	BMI	Duration of illness
oVEMP parameters				
N1 Latency (milliseconds)	R	-.089	.178	-.311
	P-value	.590	.280	0.054
P1 Latency (milliseconds)	R	-.321	.134	.014
	P-value	.046	.415	0.934
N1-P1 Amplitude (µV)	R	-.155	-.653	.243
	P-value	.340	.000	0.131

Table 6 shows no significant linear correlation between the opening pressure and the studied parameters before tapping (P>0.05)**.**

Table (6) Correlation between the opening pressure and the percent of change of oVEMP parameters before tapping

Percentage of change		Opening pressure
oVEMP parameters		
N1 Latency (milliseconds)	R	.128
	P-value	0.446
P1 Latency (milliseconds)	R	.066
	P-value	0.694
N1-P1 Amplitude	R	-.032

(μV)	P-value	0.851

Table 7 shows significant negative correlation between the opening pressure of CSF and N1-P1 amplitude (r= -.310, P= 0.052). There was a significant positive correlation between the opening pressure of CSF and latencies of N1 (r= .283, P= 0.081) and P1 (r= .362, P= 0.024).

Table (7) Correlation between the opening pressure and the parameters under study after tapping

Percentage of change		**Opening pressure**
oVEMP parameters		
N1 Latency (milliseconds)	R	.283
	P-value	0.081
P1 Latency (milliseconds)	R	.362
	P-value	0.024
N1-P1 Amplitude (μV)	R	-.310
	P-value	0.052

Discussion

Patients with idiopathic intracranial hypertension (IIH) have an elevated intracranial pressure (ICP) in absence of any tumor, venous drain or CSF disorders. For the clinical management and follow-up of patients with IIH, the possibility of non-invasively monitoring changes in ICP over time could potentially reduce the need for invasive diagnostic lumbar drainages (LD) **[8]**.

In our study, there was significant effect of lumbar puncture in N1-P1 amplitude in the patient group from 3.4 μV (±1.9) to 3.9 μV (±2.3) with (P-value=0.012) comparing to healthy controls (6.6 μV (±3.8) (P-value=0.001).
Our results agreed with some authors who found that the mean amplitudes of air conducted stimulation (ACS) oVEMPs were significantly increased from 5.0 (±2.4) μV to 8.2 (±5.1) μV by the spinal tap with (P value = 0.004) **[9]**.
These results were explained from previous studies who found that ACS oVEMP are suppressed by an increasing ICP to a much greater extent than bone conducted vibration (BCV) oVEMP. This suggested that the increase in ICP (positional induced or by IIH) leads to an increased intraotic pressure via the vestibular and cochlear aqueduct, and this in turn pushes the stapes at the oval window slightly outward **[10]**. This would result in an increased stiffness of the sound transmission system and therefore less efficient transfer of air-conducted acoustic energy from the external ear canal to the otolithic afferents in the vestibulum. Bone conducted vibration, contrarily, does not primarily rely on this sound transmission system and is therefore not significantly suppressed by an increased ICP **[11]**.

The current study revealed that there was a significant negative correlation between the opening pressure of CSF and N1-P1 amplitude of oVEMPs. These results agreed with this study, they found a negative correlation between CSF opening pressure in their study, their explanation was that increased ICP may trigger several mechanisms that accelerate transmission at synapses **[12]**. In addition, the optic nerve damage might be associated with inflammatory factors related to increased ICP and supported the role of inflammation in the disease **[13]**.

It can be postulated that these unclear mechanisms cause increased ICP initially and the contribution of several additional inflammatory or genetic factors that may lead to changes in synaptic transmission play a role in the uncovered pathogenesis of IIH **[14]**.

Conclusion

In conclusion the increased intracranial pressure proved to decrease the amplitude of oVEMP and the taping of CSF proved to enhance the amplitude of VEMP.

Lists of abbreviations
IIH: Idiopathic intracranial hypertension
ICP: intracranial pressure
oVEMP: ocular vestibular evoked myogenic potentials
CSF: cerebrospinal fluid

Declarations
Authors report that the content has not been published or submitted for publication elsewhere
Competing interests

Authors have no competing interest, and the work was not supported by any organization.

Availability of data and materials
Authors report that the datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Ethical approvals and patient consents

Ethical approval The FM-BSU REC had approved the human study from the ethical point of view. The FM-BSU REC is operated according to guidelines of the Declaration of Helsinki, International Conference of Harmonization, and United States Codes of Federal Regulations and registered in under the Federal Wide Assurance.

Ethics Approval No (FWA00015574).

Approval date (February 3, 2019).

All participants understand the risks and benefits of the study and gave verbal and written informed consent.

Authors' Contribution
RE participated in the neurophysiological assessment, collection and interpretation of data and helped to draft manuscript. DG performed the neurophysiological assessment, collection, and interpretation of data. HH participated in study design and helped to draft manuscript. MM participated in study design, collection, and interpretation of data and helped to draft manuscript. All authors read and approved the final manuscript.

Consent for publication
Not applicable

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