Analysis and interpretation of air-conducted ocular vestibular-evoked myogenic potentials (AC-oVEMP) – our experience in healthy adults

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ABSTRACT:

Background: Ocular vestibular-evoked myogenic potential (oVEMP) is one of recently introduced tests used to assess the function of the equilibrium system. It is still under research and no consensus has been reached yet.

Aim: To analyze AC-oVEMP response parameters in subjects with no history of neurological or vestibular deficits.

Material and Methods: The AC-oVEMPs collected from 50 subjects (100 ears) were analyzed in this prospective study for the response presence in the time domain, the latencies and amplitudes of the waves.

Results: No statistically significant differences were observed between the right and left ear considering both N1 latency, and amplitude. Significant differences were noted when comparing the groups <40 yo vs ≥40 yo (shorter latencies and higher amplitudes were observed in subjects <40).

Conclusions and Significance: This thorough AC-oVEMP analysis in a group of healthy volunteers facilitated the proposal of reference ranges with a simultaneous indication of age-related differences. Shorter oVEMP latencies and higher amplitudes were observed in subjects <40 yo, while in the subjects ≥40 yo the latencies were longer and the amplitudes lower.

KEYWORDS: hearing loss, utricle, vertigo, vestibular evoked myogenic potentials, vestibular nerve

ABBREVIATIONS

AC-oVEMP – ocular vestibular-evoked myogenic potential to air conduction
SCDS – superior canal dehiscence syndrome

INTRODUCTION

Ocular vestibular-evoked myogenic potential (oVEMP) is one of recently introduced tests which are used to assess the function of the equilibrium system. Air-conducted oVEMP (AC-oVEMP) is performed to assess the morphology latency, amplitude of potentials evoked in oculomotor muscles. The stimulation of the utriculus with an acoustic stimulus applied to the ear generates an impulse which, via the superior vestibular nerve, leads to the stimulation of the inferior oblique muscle which is more pronounced in the contralateral side to the stimulated ear [1, 3]. Ocular muscle movement caused by the activation of the vestibular system is called the vestibulo-ocular reflex [1, 2].

VEMP test is a valuable diagnostic tool used in the diagnostics of the diseases that affect the labyrinth, e.g. Meniere's disease, or superior canal dehiscence syndrome (SCDS), vestibular nerve problems (in case of tumors affecting this nerve or demyelinating diseases) and the pathologies of the effector muscles (e.g. in myasthenia) [4–7]. VEMP is one of the most effective diagnostic tools in the case of SCDS [8, 9].

The methodology of oVEMP examination is still under research and no consensus has been reached yet.

AIM

The aim of this study was to analyze AC-oVEMP response parameters in healthy adults with no history of neurological or vestibular deficits.

MATERIAL AND METHODS

Subject description

Fifty subjects, 34 females (65%), and 16 men (35%), mean age 42.8 years ±12.45 with no otological or neurological problems were tested in this prospective study.

The subjects were divided into age groups to define a restricted age span for healthy population. The first group consisted of sub-
Acoustic stimuli consisted of 500 Hz frequency tone bursts, exact Blackman-windowed, and of 5-ms duration. They were presented unilaterally, one ear at a time, for contralateral recordings of oVEMPs. The stimuli were delivered via ER3A insert earphones (Etymotic Research, Inc. Elk Grove Village, IL) at 100 dBnHL intensity.

According to the literature, the averaged number of acquired sweeps should be from 30 to 1500 at a time recorded continuously [12, 13], but prolonged fixation of gaze on one point causes lacrimation and the necessity to blink, which results in the artifacts contaminating the response. Testing that long one ear at a time causes patient fatigue [3]. In the present study, the reduction in oculomotor muscle fatigue was attempted by diminishing the number of sweeps to 32 per set and increasing the number of acquired sets to 5 [13]. Subsequently, the recorded responses were averaged (all together), so a higher number of recorded responses averaged in one waveform was obtained reaching 160 sweeps.

**AC-oVEMP data analysis**

The recorded AC-oVEMP waveforms were analyzed for the response presence in the time domain. The first distinctive negative peak was identified as N1 based on typical visual identification between 8 and 14 ms, followed by a distinctive positive peak P1 (Fig. 2.). The latencies and amplitudes of N1 were measured. The lack of a clear N1 followed by P1 wave was defined as no response.

**Ethical consideration**

This study is a part of a retrospective-prospective project that was approved by the Institutional Ethics Committee Review Board. The patients have given full written and informed consent for the participation in this study. The project conforms to The Code of Ethics of the World Medical Association (Declaration of Helsinki).
Regarding gender of the subjects N1 wave latency was slightly longer in males than in females. However, it was not a significant difference (P = 0.43). A significantly higher N1 amplitude was found in males (3.96 µV) than in females (3.29 µV), P = 0.014 (Tab. IV.).

DISCUSSION

oVEMP is used to assess the functions of the utriculus and ascending vestibular pathways via the vestibulo-ocular reflex [2, 3, 7, 9, 14].
The stimulation of the utricular macula triggers the reflex in oculo-motor muscles. Presumably, the potential evoked from the inferior oblique muscle is not influenced by other cranial nerves (such as the cochlear and facial nerve) [3] and the oVEMP potential originates from the vestibulo-ocular reflex via the superior branch of the vestibular nerve. oVEMP responses are absent in patients who suffer from disorders of the superior branch of the vestibular nerve (e.g., in neuritis vestibularis) [2], and are normal in patients with dysfunctions of the inferior branch of the vestibular nerve [2, 15].

oVEMP may be performed both in children [10] and in adults, but the diagnostic value decreases with age. Tseng et al. [10] obtained oVEMP in 100% of study participants aged 20–59 and only in 40% of the population older than 70 years [10, 11]. N1 latency extended with age, while the amplitude decreased [2, 4, 10, 14, 16]. According to the literature, the amplitude decreases by an average of 2.9 µV per decade [4, 16], while the latency increases by 0.12 ms [14]. Similar results were obtained in the present study, with the latency increasing with age. The reduction in oVEMP amplitude is explained by the reduction in the number of neurons of the vestibular nerve with age and decreasing number of epithelial hair cells in the vestibule. According to Rosenhall [17] the number decreases by 6% per decade. Numerous authors confirmed a higher risk of otolith organ dysfunction with age [4, 18]. Nguyen et al. [19] reported a decrease in oVEMP amplitude in subjects over 50 years old without any significant change in wave latency.

Piker et al. [11] noted that oVEMP amplitude was higher in older subjects with stimulus frequency of 750 Hz (68% of participants) and 1000 Hz (38%), while in the majority of younger individuals the highest amplitude was obtained with stimulus frequency of 500 Hz and 750 Hz. Piker et al. [11] divided a group of subjects into 3 age subgroups (18–39 yo, 40–59 yo, and over 60 yo). No statistically significant intergroup differences were noted for young adults (18–39 yo) and middle-age adults (40–59 yo). However, they noted a marked reduction in amplitude value in older adults (≥60 years). In the present study, statistical analyses revealed differences and similarities between age groups. Initially, each age group covered a decade. However, no significant differences were found either between two younger groups (<30 vs 30–39 yo), or between two older groups (40–49 yo vs ≥50 yo). Significant differences were noted when comparing the groups <40 yo vs ≥40 yo. In the present study, analyzed N1 latency values and amplitudes were the basis for the proposed reference ranges for the healthy population in two age groups presented in Tab. III.

The present study revealed significant differences regarding amplitude values between males and females. Some authors [4, 14] did not report any significant differences between oVEMP latency and amplitude in males and females, and others, like Brantberg et al. [12], and Rosengren et al. [4] reported higher oVEMP N1 latencies in men. In the presented study, the results showed a significantly higher N1 amplitude in males. Some authors stated [14] that N1 latency value depended on the size of the head and the muscle mass. However, no study is available to confirm such a hypothetical correlation. No such measurements were conducted in the present study either. Therefore, a prospective study would be interesting to assess the correlation between head circumference, muscle fatigability, fat level, weight, BMI and oVEMP latency and amplitude.

**CONCLUSIONS**

This thorough AC-oVEMP analysis in a group of healthy volunteers facilitated the proposal of reference ranges with a simultaneous indication of age-related differences. Shorter oVEMP latencies and higher amplitudes were observed in subjects <40 years old, while in the subjects ≥40 the latencies were longer and the amplitudes lower. A higher amplitude of oVEMP responses was observed in males. No other differences were found between males and females regarding AC-oVEMP response.
REFERENCES


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