

# Cervical Vestibular Evoked Myogenic Potential (c-VEMPs) Assessment in Workers with Occupational Acoustic Trauma

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## Abstract

It's well known the noise effect relates to the hearing function while there are a very few studies connected to the vestibular disease. The aim of this study is to evaluate c-VEMPs responses in workers with noise induced hearing loss and exposed to noise in order to prove the possibility of damage in the vestibular *via*. We examined 60 workers with noise induced hearing loss and 30 office employees. The results highlight an increased latency and a shorter amplitude in workers exposed to noise. We found normal values in the control group. Therefore our data show vestibular damages in workers exposed to noise, thus proving that c-VEMPs represent a simple and not invasive method to identify a possible vestibular dysfunction.

## Keywords

c-VEMPs, Occupational Acoustic Trauma, Noise Induced Hearing Loss, Sacculocollic Reflex Pathway, Audiometry

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## 1. Introduction

In a 1994 study, Shupak found vestibular derangements in laboratory animals exposed to high levels of noise [1]. Golz, in 2011, asserted that only subjects with noise induced asymmetrical hearing loss may be evidence of

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vestibular disorders [2]. Recently, some authors have showed vestibular symptoms among subjects exposed to occupational noise [3]. Wang observed caloric and vestibular evoked myogenic potential abnormal responses in 45% and 50% of workers exposed to noise [4]-[6]. The cervical vestibular evoked myogenic potential (c-VEMPs) is a reliable clinical test to assess the integrity of the inferior vestibular nerve or the saccular one. Using an electromyograph (EMG), at the beginning we can record a positive wave (P1) at 13 ms (milliseconds) and then a negative one (N1) at 23 ms, predominately arising from the side ipsilateral to the ear being stimulated at short latency. Clinical and neurophysiological data show that c-VEMPs arise from a pathway which includes the saccular macula, the inferior vestibular nerve, the lateral vestibular nucleus, the medial vestibulospinal tract and the ipsilateral motoneurons of the sternocleidomastoid (SCM) muscle.

The aim of this study is to evaluate c-VEMPs responses in workers with noise induced hearing loss and exposed to noise in order to prove the possibility of damage in the vestibular *via*.

## 2. Material and Methods

In order to record the c-VEMPs, we used an ICS Chart EP 200 VEMP monitor which provides instant feedback on how much contraction of the sternocleidomastoid is needed. We also made use of a MADSEN OTOflex 100 tympanometer and a MADSEN Astera audiometer to complete diagnostic procedures. We recruited 60 workers with noise induced hearing loss and hearing threshold of 4 kHz > 40 dB. They were male with an average age of  $34.4 \pm 3.5$  years.

The control group included 30 males with the same average age and a normal hearing capacity. All subjects didn't report any otologic personal history (e.g.: otorrhea, otodinia) or neurological disorders. They were put through audiometric examination, impedenziometric tests and cVEMP's assessment.

We also investigated possible statistically significant differences between exposed and not exposed subjects, using a non parametric test.

## 3. Results

All the control group subjects showed an auditory threshold within 15 dB HL for frequencies from 250 to 8000 Hz, with type Atympanogram and normal acoustic reflex, while the exposed group subjects had a sensorineural hearing loss by acoustic trauma as mild to moderately severe (deep to 4000 Hz from 40 dB to 70 dB). In addition, the subjects had an exposure to noise with a Leq/8 hours ranged from 85/90 dBA and a length of service of 10 - 15 years.

Out of 120 ears examined in the experimental group, in 28.3% (34 ears) c-VEMPs were absent. In 36.6% (44 ears), the latency was increased and amplitude peak to peak reduced. The c-VEMPs were normal in 35.1% (in 42 ears). Therefore, the c-VEMPs were abnormal or absent in 64.9% of the workers. All controls showed c-VEMPs with normal amplitude and normal latency (**Table 1**).

Referring to statistical analysis between the exposed group who had shown apparently normal responses to c-VEMPs and that of the controls, were highlighted highly significant differences between the two groups with regard to both the latency that the amplitude, with values of p respectively 0.001 and 0.003.

Workers with noise induced hearing loss showed an increased latency and a shorter amplitude peak to peak at c-VEMPs test. All workers examined also highlighted statistically significant differences than the control group.

## 4. Discussion

Our results are comparable with the one reported by Kumar [7]. In a group of workers with noise induced hearing loss, he found anomalous or absent c-VEMPs responses in 64% of the sample group and concluded that the possibility of vestibular dysfunction, specially the saccular pathway, is high in individuals with noise-induced

**Table 1.** VEMP responses in both exposed and not exposed groups.

	Total n. of ears	N. of ears with normal VEMP present	N. of ears with VEMP abnormal (increased latency/reduced amplitude)	N. of ears with VEMP absent
Exposed	120	42 (35.1%)	44 (36.6%)	34 (28.3%)
Not exposed	60	60 (100%)	0	0

hearing loss. Recently Akin shared our conclusions proving that the sacculocollic pathway may be susceptible to noise-related damage [8]. However his data showed that 33% of the noise-exposed subjects had abnormal cVEMPs. This obtained value is certainly lower than our and Kumar's one [7]. Wang reported that a saccular damage can cause an abnormal vestibular evoked myogenic potential (e.g.: absent or delayed c-VEMPs) in workers with bilateral 4-kHz notched audiogram and hearing threshold of 4 kHz > 40 dB [4] [5]. Lamm and Arnold asserted that a blood flow decrease can lead to a permanent auditory threshold reduction and abnormal cVEMPs responses [9].

The obtained data suggest that a damage in the sacculocollic reflex pathway can cause a vestibular disorder. So, metabolic disorders in the sacculocollic reflex can be in charge of abnormal c-VEMPs in workers with noise induced hearing loss.

## 5. Conclusion

Our results bring us to the following conclusion: workers with noise induced hearing loss and bilateral 4-kHz notched audiogram and hearing threshold of 4 kHz > 40 dB, are reported abnormal or absent c-VEMPs. This value suggests that the vestibular system, above all the sacculocollic reflex pathway, is always damaged. The c-VEMPs represent a simple and not invasive method to identify a possible vestibular dysfunction in workers exposed to noise.

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