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ORIGINAL ARTICLE

# Vestibular Evoked Myogenic Potential in Cases of Vestibular Schwannomas

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**Objectives:** The aim of this study is to record the VEMP changes that occur in patients with vestibular schwannoma to assess vestibulospinal reflexes.

**Material and Methods:** This study was carried on fifteen patients with vestibular schwannoma. Fifteen persons not suffering from any vestibulo-cochlear problem were subjected to VEMP recordings as controls.

**Results:** In this study, 3 patients (20%) had no VEMP waves on the affected side (but the waves were preserved on the other side), 11 patients (73.4%) had no VEMP waves bilaterally, and 1 patient (6.6%) had VEMP waves preserved on both sides As for the latencies of p1, n1 waves and peak to peak amplitude variation, VEMP could be elicited only in 4 patients (26.8%). There was a significant difference between the patients and controls in regard to mean p1 and n1 latencies but there was no significant difference between the peak amplitudes of patients and controls.

**Conclusion:** VEMP can be a good indicator for the function of the vestibulospinal reflexes than other physiological examinations in cases of vestibular schwannoma.

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## Introduction

Although vestibular schwannoma (VS) accounts for more than 90% of cerebellopontine angle (CPA) tumors, its origin from either superior or inferior vestibular nerve cannot be determined except at surgical exploration[1].

The caloric test can assess the function of the superior vestibular nerve. There has been no confirmed clinical test other than VEMP's for examining the function of the inferior vestibular nerve [2, 3].

VEMP's are muscle reflexes recorded by surface electrodes following repeated high-intensity sound stimulation, using an averaging technique similar to that used to record cerebral auditory evoked potentials [4] .

This test for both qualitative and quantitative influences of vestibular system on muscles of head, neck and trunk has make use of the saccule[3].

The proximity of the saccule to the cochlear duct, its embryologic relationship and its vestibular role has provided the use of sound as a stimulus to initiate a vestibular influence on the postural muscles [5].

Experiments in animals showed that the saccule acts as an acoustic receptor in lower species [6]. Vestibular fibers of the squirrel monkeys as guinea pigs are sensitive to sound [7].

The goal of this work is to study VEMP changes in cases of vestibular schwannoma that might be used in the future as a cost effective tool in the diagnosis of vestibular schwannoma and assessment of the vestibulospinal reflexes.

This study was carried on patients suffering from VS, attending outpatient clinic at Otorhinolaryngology Department, Alexandria University Hospital. All patients diagnosed by MRI as having VS were included regardless of the size of the tumor.

## Subjects

This study was carried on fifteen patients; 11 females and 4 males suffering from VS, with the age ranging from 20 to 63.

Fifteen persons not suffering from any vestibulo-cochlear problem were included as controls. Their age and sex were matched with those of patients.

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## Method

Controls in this study were subjected to detailed history taking, thorough ENT examination and basic audiological work-up. In order to exclude any disorder that would affect the VEMP results.

***Patients were subjected to:***

1- Detailed history taking including the main symptoms of the tumor (hearing loss, tinnitus and vertigo); as well as other symptoms.

2- Thorough ENT examination.

3- Complete neurological examination to determine affected cranial nerves.

4- Radiological investigations including:

   a- Computed Tomography (CT) to study the temporal bone pneumatization for operative purposes.

   b- Magnetic resonance imaging (MRI).

5- Caloric test:

6- Complete standard audiological work up including PTA, tympanometry, stapedial reflexes, speech audiometry, ABR. 7-VEMP's [3].

The following paradigm was applied to subjects starting with the healthy ear: (Figure 1)

1- Recording in the resting supine position in absence of both stimulus and muscle contraction as a baseline.

2- Recording in the presence of stimulus only to study the effect of stimulus in absence of muscle contraction.

3- Recording in the presence of both stimulus and muscle contraction.

The data were transferred to Statistical Package for Social Science (SPSS) software version 17, where check for data normality were done using Kolmogorov and Smirnov test which was not significant (normally distributed data), so descriptive statistics were carried out to yield range, mean and standard deviation. For analytical statistics, Students t test was used for comparison of means. An alpha error of 5% and a beta error of 20% were adopted in the present study.

## Results

The age of the patients ranged from 20 to 63 years with a mean of 41.8. While the age of the controls ranged from 26 to 55 years with a mean of 42.3.

All of the 15 patients showed caloric weakness, ranging from 25% to 100% with a mean of 61%.

All 15 patients had abnormal ABR with the waves either absent or of delayed latencies.

The tumor size in the cerebellopontine angle (CPA) ranged from less than 2 cm. to greater than 3 cm. in the greatest dimension but 80% of the patients had large sized tumors.

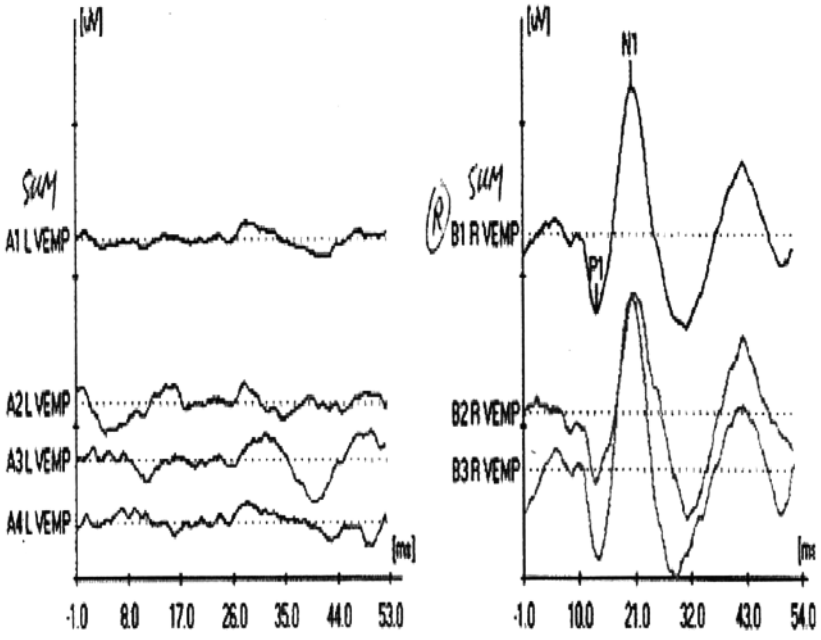


**Figure 1.** On the left figure VEMP response is lost with no discernable waves. On the right figure VEMP response is preserved . P1 designates the potential that occurs at 13 msec , N1 designates the potential that occurs at 23 msec .

**Table 1.** Vestibular evoked myogenic potential wave form in the studied patients group as related to the site of the tumor

| State of the wave | Number of patients | Percent (%) | Site of the tumor |
|---|---|---|---|
| Preserved bilaterally | 1 | 6.6% | CPA+brainstem compression |
| Absent bilaterally | 11 | 73.4% | CPA+brainstem compression |
| Preserved contralaterally | 3 | 20% | CPA |

**Table 2.** Patients and controls as regards latency of P1 wave.

| Latency (ms) | Patients P1 | Controls P1 | T* | P* |
|---|---|---|---|---|
| **Range** | 13-15.5 | 7.9-13.6 | | |
| **Mean±S.D.** | 13.9± 0.970.01 | 11.52±1.71 | 2.922 | 0.01 |

**Table 3.** Patients and controls as regards latency of N1 wave.

| Latency (ms) | Patients N1 | Controls N1 | T* | P* |
|---|---|---|---|---|
| **Range** | 22.8-26.5 | 18.85-24.25 | | |
| **Mean± S.D.** | 24.36 ± 1.34 | 21.93 ± 1.65 | 2.927 | 0.009 |

One patient (6.7%) had a tumor less than 2 cm, 2 patients (13.3%) had a tumor 2 to 3 cm and 11 patients (80%) had a tumor more than 3 cm .

One patient out of the 15 patients had preserved VEMP wave form on the affected side. 4 patients had preserved VEMP wave form on the opposite side including the former patient. In 11 patients there was no response on either side. Table 1 shows the VEMP wave forms in relation to the site of the tumor.

The peak to peak amplitude recorded in the patient with preserved response bilaterally showed marked decrease on the ipsilateral response (3.31 μv) than on the contralateral one (12.4 μv).

The latency of P1 recorded in the patients was compared to that recorded in the controls. There was a significant difference between patients and controls as regard P1 latency. (Table 2)

The latency of N1 recorded in the patients was compared to that recorded in the controls. There was a significant difference between patients and controls as regard N1 latency. (Table 3)

## Discussion

Despite the fact that the origin of many VS is from the inferior vestibular nerve, until recently there has been no reliable method for evaluating the inferior vestibular nerve function [8]. Although MRI gives reliable information about the size, relations to neighboring structures and tumor consistency whether solid or cystic, it can't give any reliable information about the nerve of origin of the tumor.

VEMP reflects a function different from that of the ABR and the caloric test. In other words it is likely that the VEMP reflects a function different from those of the cochlear nerve or the superior vestibular nerve [2,8].

VEMP might be more sensitive than other physiological examinations for early acoustic tumors affecting only the inferior vestibular nerve and vestibulospinal reflexes [8]. This was also reported by Murofushi et al [9].

In the present study, 3 patients (20%) had no VEMP waves on the affected side (but the waves were preserved contralaterally), 11 patients (73.4%) had no VEMP waves on both sides. All 11 patients had large tumors with brainstem compression explaining not only the ipsilateral loss of VEMP waves but also the contralateral loss due to distortion of both ipsi and contralateral vestibulospinal tracts. In all these patients the MRI's showed brainstem shift in contrast with the other patients with preserved VEMP's contralaterally. One patient (6.6%) had VEMP waves preserved on both sides; in this patient, the caloric test showed canal paresis in the affected ear indicating that the inferior vestibular nerve is spared and the tumor most probably arises from the superior vestibular nerve, which was proved intraoperatively, also there were no brainstem compression .This explains the

presence of VEMP waves bilaterally. But in this patient there was a marked decrease of amplitude ipsilaterally as compared with the other side, as a sign of the ipsilateral pathology. Although VEMP technique encompasses only neck and shoulder muscles, it might give us an insight of the function of the vestibulospinal reflexes which are important in controlling balance.

According to Chen et al [17], the average size of tumor with unilaterally absent VEMP response was 2.6 cm. whereas one tumor with preserved VEMP response was 1.2 cm. In the present study the average tumor size with absent VEMP response was 3.5 cm. however 1 patient had a tumor size of 4 cm. with preserved VEMP bilaterally.

Chen et al [10], found biphasic P13, N23 myogenic potential of ipsilateral sternocleidomastoid muscle in all stimulated ears of the controls (100%) ; also the controls of the present study showed the same response.

In this study the origin of the tumor in the operated patients could not be determined due to large size of the tumors, except in one patient with weak caloric response and normal VEMP response, where the tumor had originated from the superior vestibular nerve. Chen et al [10], mentioned an operated patient with a normal caloric response and no VEMP, where the tumor had originated from the inferior vestibular nerve. Although the nerve of origin can frequently be ascertained on smaller tumors, it is frequently extremely difficult for a surgeon to determine the nerve of origin in larger tumors.

Matsuzaki et al [8] reviewed the clinical records of 33 patients with VS diagnosed by MRI who underwent PTA, ABR, caloric testing and VEMP testing. Among them only two patients (6%) showed normal ABRs; VEMP were absent in these two cases, while caloric test revealed normal response in one and canal paresis in another case. In the present study, all the patients showed abnormal ABR and abnormal caloric testing. Only one patient with VS showed normal VEMP on the side of the tumor.

In this study it was found that one patient (6.7%) had significant decrease in the VEMP amplitude on the affected side, the rest of the patients showed absent VEMP response on the affected side. Murofushi et al[9] reported significantly decreased VEMP amplitude in 9.5% of his patients on the affected side.

As for the latencies of P1, N1 waves and peak to peak amplitude variation, VEMP could be elicited only in 4 patients (26.7%) (3 patients having contralaterally and one bilaterally). It was found that there was a significant difference between the patients and controls within mean P1 and N1 latencies but there was no significant difference between patients and controls as regards peak to peak amplitude variation. This indicates that the P1, N1 wave latencies, not the peak amplitude variation, could be reliably used to diagnose CPA lesions.

Murofushi et al [9] pointed that 17% of patients had prolonged P1, N1 latency in the contralateral side. In this study the P1, N1 waves latencies recorded contralaterally in 4 patients (26.7%) showed statistically significant prolongation because these patients had large tumors which compressed the contralateral side.

The ipsilateral latencies of the VEMP waves, in this study, there was only one patient with preserved response in the affected ear, but with elevated latency of N1 compared to the other ear. According to Ochi et al[2] the latency of the affected ears were all elevated compared to non-affected ears. It was suggested that the inter-aural difference of thresholds might be useful to detect vestibular VS. It was suggested by Ochi et al [2], that VEMP could be a valuable screening tool to rule out patients with vestibulopathies, particularly VS, but it would miss patients when the VS arises from the superior vestibular nerve. So ABR, caloric test, and balance test have to be added to rule out VS in some cases.

The control group in this study, 15 persons showed brief responses, having a mean latency of 11.52 msec for P1 and 24.36 msec for n1 and the peak to peak amplitude ranged from 8.48 μV up to 34.72 μV.

According to Heide et al [11] the VEMPs waves in the control group were always elicitable on the side of the stimulation; latencies of P1 and N1 and the amplitudes were within the normal range; with a mean latency of 11.6 msec for P1, 20 msec for N1 and the peak to peak amplitude was very variable ranging from 26 μV to 382 μV.

## Conclusion

VEMP might be an indicator for the function of the vestibulospinal reflexes bilaterally. Information about these reflexes might help good planning of postoperative rehabilitation in combination with visual and proprioceptive systems.

The P1, N1 waves latencies could be reliably used to diagnose CPA lesions.

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