

# Vestibular evoked myogenic potential

## Potencial evocado miogênico vestibular

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### SUMMARY

**Introduction:** The Vestibular Evoked Myogenic Potential (VEMP) is a promising test for the evaluation of the cholic descending vestibular system. This reflex depends of the integrity from the saccular macula, from the inferior vestibular nerve, the vestibular nuclei, the vestibule-spinal tract and effectors muscles.

**Objective:** Perform a systematic review of the pertinent literature by means of database (COCHRANE, MEDLINE, LILACS, CAPES).

**Conclusion:** The clinical application of the VEMP has expanded in the last years, as goal that this exam is used as complementary in the otoneurological evaluation currently used. But, methodological issues must be clarified. This way, this method when combined with the standard protocol, can provide a more widely evaluation from the vestibular system. The standardization of the methodology is fundamental criterion for the replicability and sensibility of the exam.

**Keywords:** methods, vestibular function tests, postural balance, saccule and utricle.

### RESUMO

**Introdução:** O Potencial Evocado Miogênico Vestibular (VEMP) é um teste promissor para a avaliação do sistema vestibulo-cólico descendente. Este reflexo depende da integridade da mácula sacular, do nervo vestibular inferior, dos núcleos vestibulares, das vias vestibulo-espinais e do músculo efetor.

**Objetivo:** Realizar revisão sistemática de literatura pertinente por meio de bases de dados (COCHRANE, MEDLINE, LILACS, CAPES).

**Conclusão:** A aplicação clínica do VEMP expandiu-se nos últimos anos, com o objetivo de que este exame seja utilizado como complementar na avaliação otoneurológica atualmente utilizada. Porém, questões metodológicas devem ser esclarecidas. Dessa forma, este método, quando combinado com o protocolo padrão, poderá fornecer uma avaliação mais abrangente do sistema vestibular. A padronização da metodologia é fundamental critério para a replicabilidade e sensibilidade do exame.

**Palavras-chave:** métodos, testes de função vestibular, equilíbrio postural, sáculo e utrículo.

## INTRODUCTION

The Vestibular Evoked Myogenic Potential (VEMP) is considered by the literature as a recent technique and complementary for the evaluation of the vestibular function (1). This reflex depends on the integrity of the saccular macula, from the inferior nerve, the vestibular nuclei, the vestibule-spinal tract and effectors muscles (2,3,4).

For the clinical application of this test are needed uniform parameters (4-6).

In the literature is observed a crescent number of articles about this matter. This way, the present systematic review had as main goal describe the main aspects referring to VEMP.

The researched data bases were: COCHRANE (*The Cochrane Controlled Trials Register*), MEDLINE (*Medical Literature, Analysis and Retrieval System on Line*), LILACS (Literature Latin American of Health Science) and CAPES journals (Coordination of Personal Development of Superior Level; using as time limitation the period from 1992 to 2009). The descriptors used were: *clinical vestibular tests, vestibular-evoked myogenic potential, vestibular function* and they equivalent in Portuguese and Spanish.

The performed research comprised the systematic review of literature and critic evaluation of the articles. Were included transverse clinical studies, prospective longitudinal and retrospective, articles of review and meta-analysis, report of cases and review of paper work. Were excluded editorials, theses and dissertations.

In the large researched data basis, were found 413 summaries of scientific articles, that were related to the work objective.

From 413 summaries, 72 were selected from the criteria of inclusion. The selection was made by the evaluation of the titles and from the identified summaries in the initial search for all researchers, in a independent and blinded way. When the title and the summary were not enlightening, we sought for the full article. This stage result in the final selection of 30 final articles. They were selected by the evaluation of its content, research design and generalization of results among the populations and clinical groups, as the specificities and variations of used protocol, methodological quality of each article and accuracy of results.

The proposition of studying VEMP as complement of otoneurologic evaluation, stimulated investigations of the confirmation of the peripheral receptor and from the

neural pathways involved in the formation of this potential, from the variable and parameters of stimulation and from the records that influenced in the answers obtained, as its clinical applications (1,4-7).

Hearing organ of inferior vertebrates, the saccule is, in humans, the vestibular organ that better respond to the sound (8-10). A few characteristics sustain this assumption. In first place, the localization of the saccule, immediately below the platinum, is the ideal position to receive the acoustic stimulus (10,11). In second place, the most of the neurons of the vestibular nerve are sensible to the clicks has its origin in the saccular macula and protrude in the vestibular nuclei inferior and lateral (10,11).

Experimental studies demonstrated that the threshold of excitability from the saccular macula by the sound is elevated in subjects, being around 80 dB NPS. The same high threshold was observed in clinical works, that evaluated the influence of different intensities of stimulus under the myogenic answers evoked by sound stimulation (2,9,10).

This way, was proposed be the VEMP an reflex arch that involves the inner ear, the brainstem and the vestibule-spinal pathway. This reflex arch is considered one of the responsible for the maintenance of the body balance (2,10,12,13).

The VEMP can be obtained from a device of hearing potential (4,14). In literature, still there is no consensus related to that standardization for the obtainment of this potential, being great the heterogeneity of protocols used in the clinical applicability (1,4-6,12).

As a basic principle of evaluation of any evoked potential, is measured the time between the stimulus and the answer, classifying as normal or altered from the time of duration and from the morphology of the generated electric waves (1,12,14).

The trace obtained consists by two complexes of biphasic waveforms. The first biphasic potential present positive peak (P) with average latency of 13 miliseconds (ms), followed by a negative peak (N) with average latency of 23 ms, and is called P13-N23 or P14-N21 or P1-N2 (2,7,13). The interaural difference of latency from the peaks is associated to the speed of neuronal conduction, the increase of that difference could be explained by the asymmetry of that speed, common in neurological diseases (15,16). This way, diseases that interfere in the neural conduction from the inner ear, passing through the brainstem for the vestibule-spinal tract and by the second motor neuron, can interfere in the answer. Facing that, the VEMP evaluates the final reflex; so, is not worth it for the

topographic diagnosis, but confirms or push away the airway compromise involved (2,4,5,6,11).

The extent of the answer reflects the magnitude of the muscle reflex (4-6). However, there is a interpersonal variation of mass and muscle tone (5,6,17,18). So, is used as analyzed variable referring to the amplitude from the Asymmetry Index. This index is calculated by the interaural difference from the amplitude of the response, weighted by the average response of each patient. This index is variable in studies and is considered as not significant for values between 0% to 47% (1,7,11,19).

The influence of contraction of the cervical muscles and from the intensity of the stimulus under the amplitude and the latency of the response in the record of VEMP was studied, and was observed a linear relation between the degree of muscle contraction and the amplitude of responses, but was not observed variation in the latency (18,20). The responses must be recorded by surface electromyography (EMG)

The control of muscle contraction is imperative to acquire reproducibility in results and reliability in the comparison of responses obtained in the right side and left side (4,5). The procedure to obtain the symmetric contraction still is not standardized, but the literature recommends that the level of electromyographic activity is above 150-200  $\mu$ V (4-6,18). Are averaged 100 to 250 responses of each side with repetition rate of stimulus with values among 3 to 5 Hz (4,21-24).

Regarding the type of stimulus used, can be obtained the VEMP by means of acoustic stimulation by airway, by bone pathway and galvanic stimulation (4,16,13). Problems in the outer ear or middle ear attenuate the intensity of conduction by airway. So, subjects with conductive hearing loss can present missing responses, although do not have changes in the route of the reflex (6). The bone vibration is applied directly in the inner ear. Neurophysiologic studies showed that the utricle can also be stimulated in this cases (25). So this method is indicated only to evaluate the vestibular function in individuals with conductive hearing losses (4,25). The galvanic stimulation begins directly in the vestibular nerve, and may be applied to differ labyrinthine lesions from the retrolabyrinthine ones (4,12,16). In this case, a chain of 3-4  $\mu$ A is used as impulse (4,12).

The impulse can be performed unilaterally or bilaterally. Research compared the use of those techniques. The bilateral stimulation was proposed to reduce the length of the exam and the physical load spent by the evaluated individual, mostly in children and elderly. However, it is suggested that the same is used only when necessary or in the end of the screening (19,26).

The stimulus can be promediated using clicks (2,9) (rarefied and alternated) or *tone burst* (13,16,21,22). Studies recommend the use of the *tone burst*, because the threshold of saccular excitability is lower when compared to the click, being more comfortable for the evaluated individual (23,27).

In literature, the frequency of the stimulation was described with great variety: 500 a 1000 Hertz (Hz) (6,10,11,21-23). Is it noteworthy a greater incidence in the frequency to 500 Hz, with more homogeneous and constant response (22).

Although there is differences in the positioning of the surface electrodes in the VEMP exams, it is observed, by the current and described literature, that the surface electrode is positioned, usually, in the middle third of the sternocleidomastoid muscle (ECM), with consistent and homogeneous findings (2,28).

There are many methods described for the activation of the ECM, during a exam, some authors recommend that the individual remain sitting, making pressure with the forehead under a bar positioned in front of the head (29), while others prescribe that he must remains in supine position, raising his head (8,24). Or muscle activation by the maximum sided rotation of the head, with the individual sitting (7,13,21). The literature discuss which is the best method, with advantages and disadvantages of each (7,20,21), being observed in a study that had no significant difference in the choice of the method in relation to the answer obtained, when the measures of amplitude are in agreement with the measures of the electromyographic tonic activity (30).

For the attenuation of frequencies, elimination of artefacts in the response, is used, in most of studies the band-pass filter of 20-2000 Hz, allowing a morphology of the tracing that would increase the precision of the marking of peaks (21-23).

Regarding the clinical applicability, the VEMP presents many favorable characteristics for its use: is an objective examination, not invasive, of easy execution, low cost, quick and do not bring and discomfort for the patient (3,14). However, are necessary studies for the standardization of the technique and sustainability of its use as a routine method.

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## CONCLUSION

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The Vestibular Evoke Myogenic Potential is a objective test and used to complement the otoneurologic evaluation. Researches referring to the theme expanded

because of the need into defining the acuity of this exam. Should be noted that the methodological standardization is a fundamental criteria for the reliability and sensibility of the exam.

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