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Research Article

# Masseteric Vestibular Evoked Myogenic Potential Click vs. Tone burst Normative and Gender Difference

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## ABSTRACT

The vestibular-evoked myogenic potential (VEMP) is a technique based on residual acoustic sensitivity of the sacculues, which, during the course of its evolution, functioned as an organ of hearing and still does so in primitive vertebrates. Sound-evoked vestibular responses in humans were described by Von Békésy who, using intense sounds of 128 to 134 db, evoked head movement toward the stimulated ear. These studies suggest the utility of the mVEMP as tools in the assessment of brainstem function. However, unlike cVEMPs and oVEMPs, normative data for mVEMP is lacking, and this limits their potential use in clinical settings. Consequently this study proposed to: 1) To find the normative(peak latency and asymmetric) for mVEMP using Tone burst and Clicks 2) To find the gender difference in mVEMP Methodology: Subject: A total of 40 healthy subjects (20 females and 20 males; mean age 22 ± 2 years, range 18-24 years) Results: The latencies of p11 and n21, peak-to-peak p11-n21 amplitude, and VAR of Tone Burst VEMP in healthy individuals were 12.13 ± 0.81 ms (mean ± SD), 22.54 ± 1.30 ms, 198.53 ± 64.64 μ V, and 0.13 ± 0.12, respectively. The latencies of p11 and n21, peak-to-peak p11-n21 amplitude and VAR of m-VEMP in healthy individuals were 11.45 ± 0.87 ms, 21.85 ± 1.65 ms, 81.23 ± 32.56 μ V and 0.2 ± 0.13, respectively.

**Keywords**: Tone; mVEMP; Vestibular system; Normative

## INTRODUCTION

The vestibular-evoked myogenic potential (VEMP) is a technique based on residual acoustic sensitivity of the sacculues, which, during the course of its evolution, functioned as an organ of hearing and still does so in primitive vertebrates. Sound-evoked vestibular responses in humans were described by Von Békésy who, using intense sounds of 128 to 134 db, evoked head movement toward the stimulated ear [1-5]. Displacement of the stapes footplate, which lies in close proximity to the sacculus, was thought to lead to eddy current formation within the endolymph, hair cell displacement, and activation of primary afferents. Loud sound stimuli have been used to elicit vestibular evoked myogenic potential in active sternocleido mastoid muscles (cervical VEMP, cVEMP) and inferior oblique muscles (ocular VEMP, oVEMP).For cVEMPs and oVEMPs, normative standard datas are avaliable. These vemps have found a wide application in the study of both vestibular and neurological disorders [6,7]. Vestibular stimulation at the end-organ level may also evoke ashort-latency inhibitory EMG response in active masseter muscles.This response was first demonstrated following unilateral or bilateral transmastoid electrical stimulation as a bilateral and symmetricp11/n15 biphasic wave, termed originally vestibulo-masseteric reflex (VMR) and more recently masseteric VEMP(mVEMP). Anatomical studies conducted in rats revealed that, besides a multi synaptic vestibulo-trigeminal pathway [8-10] possibly mediating excitatory long-latency trigeminal responses to vestibular stimulation [11-22], a monosynaptic connection between the medial vestibular nuclei and the trigeminal motor nucleus exists. Although not yet confirmed in humans, this crossed and bilateral vestibulo-trigeminal pathway could be the anatomical substrate of the VMR .More recently, them VEMP, was employed as part of a comprehensive battery of VEMPs for the functional assessment of the brainstem in patients with Parkinson's disease , idiopathic REM-Sleep Behaviour Disorder and amyotrophic lateral sclerosis . A mVEMP score was provided to assess the severity of brainstem dysfunction in neurological

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Consequently this study proposed to:

To find the normative(peak latency and asymmetric) for mVEMP using Tone burst and Clicks.

To find the gender difference in mVEMP.

## METHODOLOGY

### Subject

A total of 40 healthy subjects (20 females and 20 males; mean age 22 ± 2 years, range 18-24 years) participated in this study, Detailed personal history was collected for all participants to exclude previous or current medical conditions such as neurootological and stomatognathic disorders, cervical spine disturbances and migraine. In particular, to rule out conductive and/or sensori neural hearing loss. All participants underwent to na laudiometric (Maico MA 52) examination performed following international standard procedures ISO 6189-1983. All participants had normal audiograms. Subjects were seated in a dim and quiet room and were asked to contract masseters at 30%–50% of their maximal voluntary contraction, with visual feedback to help them to monitor their muscle contraction level.

### Recording parameters

**Stimulus:** During masseter contraction at the prescribed level, mVEMP were elicited through Tone burst of 500Hz (n=300–500 stimuli, 2-1-2 rise, palatue and fall, 5.1 Hz frequency), vs. Tonal Click stimulus(n=300–500 stimuli, 0.1 ms duration, 5 Hz frequency)generated by a 3505 HP attenuator driven by a Signal 5.0 script for VEMP (Cambridge Electronic Design, LTD, Cambridge, UK) and delivered through TDH-39 calibrated earphones (Telephonics, Huntington, NY) mono-aurally. mVEMP is elcited at intensity level of 90dBnH [32-45].

**Filter settings:** Rectified and unrectified EMG activity were bilaterally recorded(1902 Quad System Amplifier, Cambridge Electronic LTD, Cambridge, UK), amplified (x5000), filtered (bandwidth 5–5000 Hz) and sampled (10 KHz) within a 100 ms window (25 ms beforeand 75 ms after stimulus delivery), using an analog/digital converter(1401 power, Cambridge Electronic Design LTD, Cambridge, UK) and Signal 5.0 software for PC.Each individual recording from the subjects was repeated twice and the obtained data were averaged for P1/N1latencies. Data are given as mean (+-SD).

**Electrode montage:** In all subjects, masseter muscle EMG was recorded through surface bipolar silver/silver chloride electrodes placed in a double belly-to-tendon configuration, with the active electrode positioned in the lower third of the masseter muscle, reference electrodes placed at the middle of the zygomatic arch (zygomatic montage) respectively, and the ground electrode over the forehead. For each subject, the mVEMP were considered present when a p11/n21 wave, respectively, was clearly discernible from the averaged background EMG activity, measured in the unrectified traces, namely, when they were>2SD of the pre-stimulus unrectified mean EMG (group average: 10.426 ± 5.122 lV in the zygomatic montage).

The asymmetries in both p1 latencies and corrected amplitudes were calculated with the following formula [(Lx - Rx/Lx+Rx) * 100%]where Lx and Rx represent the latency and the amplitudes of the left and right responses (Welgampola and Colebatch, 2001). Inter-sided ifferences in peak latencies were also measured.

**Statistical analysis:** Data were computed and analysed through SPSS software. Statistical analysis was performed as group comparisonby means of the Chi-square test or ANOVA in dependenceof the data distribution and homogenicity of variances. The tested significance level was $p<0.05$ (SPSS 10.0).

The effect of age on the reflex morphology was tested with a one-way ANOVA with Tukey's posthoc test and Greenhouse-Geisser correction in case of nonspherical data, as assessed by Mauchly's test.

## RESULTS

The latencies of p11 and n21, peak-to-peak p11-n21 amplitude, and VAR of Tone Burst VEMP.

in healthy individuals were 12.13 ± 0.81 ms(mean ± SD), 22.54 ± 1.30 ms, 198.53 ± 64.64 μV, and0.13 ± 0.12, respectively. The latencies of p11 and n21, peak-to-peak p11-n21 amplitude and VAR of m-VEMP in healthy individuals were 11.45 ± 0.87 ms, 21.85 ± 1.65 ms, 81.23 ± 32.56 μV and 0.2 ± 0.13, respectively.

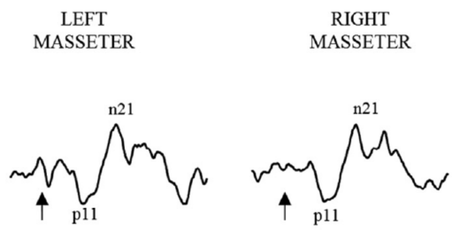


**Figure 1**: Tone burst.

The latencies p11, n21 and p11-n21 amplitude of Tone burst (Figure 1) were significantly different from those of m-VEMP($p<0.05$, paired t test). The VAR of Tone burst, however, was not different from m-VEMP. In women, the p1 and n1 peak latencies were significantly shorter in comparison with male subjects. Although statistically significant, the gender difference found was quite small in terms of absolute values (average difference: 0.4 ms for the p11, 0.5 ms for the p16 and 1.0 ms for the n21) (Table 1).

**Table 1:** Comparision of Tone burst and clicks.

| VEMP | Latency p11 (msec) | Latency n21 (msec) | Interval (p11-n21) (msec) | Amplitude(p11-n21) (μV) |
|---|---|---|---|---|
| Clicks | 11.45 ± 0.87** | 21.85 ± 1.65** | 10.4 ± 0.78* | 81.23 ± 32.56* |
| Tone burst | 12.13 ± 0.81** | 22.54 ± 1.30** | 10.41 ± 0.49* | 198.53 ± 64.64* |

* p 0.05, ** p 0.005 (two-tailed paired t-test).

p 0.05 (Wilcoxon signed-rank test).

Data are expressed as mean ± SD; TBs=short tone bursts.

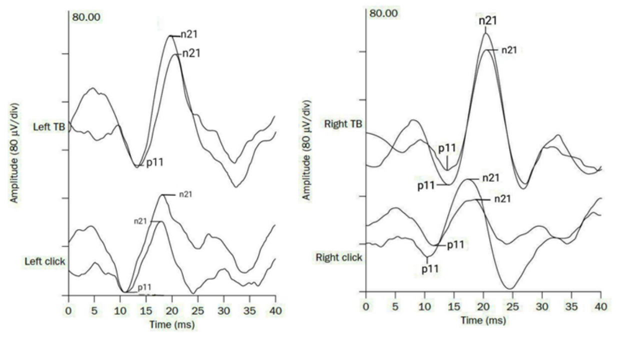


**Figure 2:** Clicks.

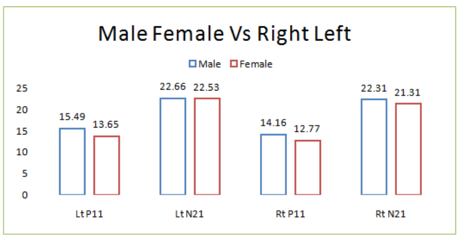


**Figure 3:** Showing gender differences.

Latency: Tone burst stimulus wave latency were prolonged compare to clicks (Figure 2) ($p<0.05$).

Amplitude: Tone burst has grater amplitude than clicks stimulus ($p<0.05$).

Asymmerty ratio: There is no significance difference in asymmetry ratio between clicks and tone burst ($p>0.05$).

On comparing different VEMP parameters between men and women (Figure 3), we found that there was no significant difference as regards threshold in the right ear (p=0.412) and threshold in the left ear (p=0.630).P11 latency was also found to be non significant(p=0.412 and P=0.987 for the right and left ears, respectively). Moreover, N21 showed no significant difference (p=0.844 and P=0.755 for the right and left ears, respectively).

There was no significant difference as regards amplitude in the right ear (p=0.920) and amplitude in the left ear (p=0.893). The results are shown in Table 1 below.

## DISCUSSION

### Electrode montage

In line with previous studies on VEMPs we found that the electrode configuration affected the characteristics of the VMR and AMR [28-29]. In particular, when the reference electrode was positioned in the zygomatic arch rather than in the mandible angle, both reflexes exhibited significantly higher elicitation rates and raw amplitudes, but no differences in corrected amplitudes [36]. The zygomatic montage, compared to the mandibular montage, has a higher inter electrode distance (IED) which, employing a broader area of recording, prevents ''reference contamination". Surface EMG recording of the masseter muscle is highly influenced by IED, since even small changes in it may result in significant differences of both amplitude and variability of the recording [37-39].

Based on these findings, we suggest that, to ensure the highest detection rate, both electrode configurations be used when recording the mVEMP.

### Intensity

In a previous work, the Vestiblar massester reflex(VMR) was found to have the same elicitation intensity threshold of the Cvem [20]. However, some differences between these VEMPs need to be acknowledged. Provided the stimulation intensity is the same, the amplitude of the mVEMP is around 30% smaller than the cVEMP [20]. In line with this finding, compared to the mVEMP, the cVEMP and oVEMP can be elicited with the proportionof 91% and 84% at 135 dB SPL respectively as well as withhigher amplitudes [40]. These data indicatethat the vestibular projection to the sternocleidomastoid and ocular muscles is more powerful than the projection to the masseters.This may be a consequence of the predominant role played by neckand ocular muscles in postural control compared with that played by jaw-closing muscles.

No comparison is possible at the moment between masseter responses to click versus tone stimulation, which is another type of stimulus commonly used to elicit cVEMPs and oVEMPs, with different degrees of sensitivity. The papers which first described VMR in healthy subjects as well as in clinical settings have all used air conducted click stimulation. For this reason, we have compared the Click and tonal stimulation [12-19, 38-42].

## CLINICAL IMPLICATIONS

VEMPs are increasingly employed for research and clinical purposes in a wide number of neurological and neurotological disorders, with a diagnostic/differential diagnostic purpose. There flexes here tested are able to indirectly study a significant portion of the brainstem and have been proven a useful complement to cervical and ocular VEMPs in the assessment of brainstem function [12,13,30,31]. VMR has the advantage of investigating the trigeminal brainstem pathways and is more tolerated than the Trigeminal Cervical Reflex (which implies a stimulation which, although not nociceptive, can be distressing for the subject). VMR also provides a crossed and bilateral response to mono or bilateral stimulations; this feature may be useful when differentiating central neurological and peripheral vestibular disorders. In the latter case, impairments in the stimulation ofthe affected side (peripheral vestibular damage) can be counter balanced by the preservation of the VMR response on the corresponding target muscle from contralateral side stimulation(preservation of central pathways) [42-54].

## CONCLUSION

Tone burst have larger peak amplitude when compare to clicks even though peak latencies are prolonged tone burst is helpful in finding the peaks easier when compare to clicks evoked mVEMP. There is no statistically significance difference between male and female.

The previous stuides show the difference in vestibular evoked potential using clicks and tone burst. In mVEMP there is lack of normative data with the comparsion of tone burst and click. Still more contraveses were found in ipsi and conta presentation. In this study we have compared the clicks and tone burst with gender difference.

In conclusion, the VEMP responses were significantly different between the stimuli of TB and click. The TB-VEMP had longer latencies p11 and n21 than m-VEMP. The norms of different stimuli should be established for clinical interpretations. For clinical diagnosis using VEMP, we recommend TB stimuli because the latencies and amplitudes of click were significantly different among several labs, including ours.

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