Section: Otolaryngology

Original Research Article

STUDY OF VESTIBULAR EVOKED MYOGENIC POTENTIAL AMONG VERTIGO PATIENTS ATTENDING A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: To administer the vestibular evoked myogenic potential (VEMP) test in the clinical evaluation of vertigo patients and to establish the utility of VEMP as a diagnostic tool in broad categories of vertigo in a tertiary care hospital in Mysore. **Materials and Methods:** It is a cross-sectional observational study conducted on 81 patients who presented with vertigo to the department of ENT at Mysore Medical College and Research Institute. After thorough clinical history, physical examination and clinical tests, they were subjected to VEMP test conducted in All India Institute of Speech and Hearing, Mysore. **Result:** In the BPPV patients, the peak-to-peak amplitudes of cVEMP were significantly smaller in the affected ears (AE) than the unaffected ears (UE) ($p < 0.05$). Further the oVEMP peak-to-peak amplitude was significantly smaller in the AE with BPPV patients than the UE ($p < 0.05$). In the Meniere's disease patients, the P1 latencies of the cVEMP were significantly longer in the AE than the UE ($p < 0.05$); however, there was no ear difference on oVEMP in this group ($p > 0.05$). There was significantly high asymmetry ratio on cVEMP in one of the two patients with vestibular neuritis (IAR>31%). **Conclusion:** In the present study the peak-to-peak amplitudes were reduced in both cVEMP and oVEMP in BPPV group, and P1 latency was prolonged in cVEMP in Meniere's disease group. This could provide information about utricle and saccule in patients with Meniere's disease and BPPV.

INTRODUCTION

Vertigo is defined as an illusion of either oneself or the environment rotating. Approximately 80% of vertigo is peripheral whereas 20% is central in origin. BPPV is most common cause of vertigo. Causes of vertigo- Peripheral vertigo: which involves vestibular end organs and their first order neurons.[1,2] Examples are Benign Paroxysmal Positional Vertigo (BPPV) which is the most common cause, Meniere's disease (MD), Vestibular neuritis (VN), Superior semicircular canal dehiscence syndrome (SSCDS), Cogan syndrome, perilymph fistulas (PLF), enlarged vestibular aqueduct, etc. Central vertigo: which involves the central nervous system from the entrance of the vestibular nerve in the brainstem and involves vestibulo-ocular, vestibulospinal and other central nervous system pathways. Examples are vestibular migraine, vestibular schwannoma, multiple sclerosis, vascular disorders like vertebrobasilar insufficiency, Lateral medullary syndrome, Cerebellar infarction, etc.[3,4]

The primary purpose of the VEMP test is to determine the integrity of otolith organ and vestibular nerve functions. VEMP – Vestibular Evoked Myogenic Potential. The clinical application of VEMP was first reported by Colebatch in 1994.[2,3] It is an electrophysiological test used to determine the function of the vestibule of the inner ear which is performed by stimulating the test ear with repetitive pulse or click sound stimulation and then measuring surface electromyogenic responses over selected muscles averaging the reaction of the muscle electrical activity associated with each sound click or pulse. There are mainly two different types of VEMP – cVEMP (cervical) and oVEMP (ocular). cVEMP measures the integrity of the saccule and inferior vestibular nerve. It is recorded by a stimulus applied to the ear that evokes a response within ipsilateral sternocleidomastoid muscle that can be recorded with surface electrodes. cVEMP measures P1 (Positive deflection), N1 (Negative deflection) latencies and peak-topeak (P1-N1) amplitude.[4,5]

oVEMP measures the integrity of utricle and superior vestibular nerve. It is recorded by surface electrodes placed underneath contralateral eye in response to sound stimulus which evokes a response from the contralateral inferior oblique muscle. oVEMP measures N1 and P1 latencies and peak-to-peak (N1-P1) amplitude.[6]

Advantages of VEMP:

1. The VEMP test is preferred because it is a non-invasive, safe test and is helpful in the correct diagnosis, clinical follow-up, and also helps to assess response to treatment.
2. VEMP recording with suitable equipment is easier and quicker to perform.
3. This test helps to diagnose vestibular pathologies like Vestibular Neuritis, Meniere's disease, Vestibular schwannoma, Intratympanic Gentamicin therapy, SSCDS.
4. Patient's compliance with VEMP testing is much better compared to other tests.

Disadvantage of VEMP

1. VEMP should be considered as a complimentary test along with other conventional vestibular function tests to improve the accuracy of diagnosis.
2. No particular VEMP parameters reliably guides towards the diagnosis of any of the vestibular pathologies.

MATERIALS AND METHODS

It was a Cross sectional observational study conducted at All India Institute of Speech and Hearing, Mysore. The main source of data for the study was patients who came to the outpatient department of Otolaryngology, Krishna Rajendra Hospital, MMC&RI, Mysore, with complaints of vertigo. For a period of One and half years from January 2021 to June 2022. A total of 81 cases presented with Vertigo.

Sample Size: Sample size, n is calculated using the formula:

$n = z^2pq/d^2$

Where,

p is prevalence of vertigo. According to the hospital records of previous years,

p = 5.71%

q = 1-p i.e., 94.29%

d = Level of precision in terms of absolute error i.e., 5%

z = Standard normal variate for 5% alpha error i.e., 1.94

Therefore, in our study the sample size is n = 81

Sampling Method: Purposive sampling

Inclusion criteria

- Patients willing to be included in the study
- Patient's age between 14 and 60 years
- Patients with peripheral vertigo

Exclusion criteria

- Patient who has cervical spondylosis, torticollis, cervical trauma.
- Patients with diagnosed central vertigo.
- Patient with systemic diseases like ischemic stroke, uncontrolled diabetes mellitus, uncontrolled essential hypertension, and severe anemia

Patients with recurrent, positional, self-limited vertigo which lasts for few seconds to minutes were categorized as probable BPPV. Recurrent, non-positional vertigo lasting for minutes to hours associated with hearing loss, tinnitus, aural fullness or allergic history were suspected to have Meniere's disease. A nonrecurring, continuous vertigo lasting for days with history of upper respiratory tract infections were categorized to have vestibular neuritis. Whereas new onset of vertigo lasting for days associated with nausea, vomiting and coexisting history of ear discharge, decreased hearing and/or tinnitus were categorized to have Labyrinthitis. Any history of comorbidities like uncontrolled diabetes mellitus, hypertension, cardiovascular accidents, cerebrovascular accidents were excluded from the study. Otological examination was performed to rule out middle ear pathologies.

Pure tone audiometry (PTA) was done for patients with history of decreased hearing and those with abnormal Tuning fork test results.

VEMP- The first deflection on the waveform was marked as P1 and the first negative deflection was marked as N1. The latencies of these waves were calculated. VEMP response was considered to be absent when there were no reproducible or replicating biphasic waveforms. The peak-to-peak amplitude i.e., P1-N1 amplitude was recorded. The inter-aural asymmetry ratio was calculated using Jongkees formula $[(\text{right} - \text{left})/(\text{right} + \text{left})] \times 100$.

The oVEMP is crossed excitatory reflex of the inferior oblique extraocular muscle. Patient is seated and instructed to maintain the upper gaze for the contraction of inferior oblique muscle.

The sites of electrode placement were prepared with skin-preparing gel. Among 3 surface electrodes, the active and reference electrodes are placed on the opposite side of the test ear. The active electrode was placed just beneath the midpoint of eye. The reference electrode was placed 2cm just below active electrode on the cheek. The ground electrode was placed on the forehead.

Statistical technique: Frequencies, Proportions or percentages, and graphical representations were demonstrated wherever necessary. Data were obtained in a specified proforma and data analysis was conducted by using Microsoft Excel, SPSS version 22 (IBM SPSS statistics, Somers NY, USA). The Mean, Standard Deviation (SD), Median, Inter Quartile Range (IQR) were used for descriptive statistics of the data. The Wilcoxon signed-rank test is a non-parametric statistical test that was used to compare the results between the affected and unaffected ears of the BPPV and MD participants. p-value (Probability that the result is true) of less than 0.05 was considered as statistically significant after assuming all the rules of the statistical tests.

RESULTS

Table 1: Mean, SD and median of age and gender distribution of the participants

Participants (N=81)	Gender	Frequency	Percentage (%)	Mean age	SD	Median age
BPPV (N=65)	Male	29	35.8	42.65	13.07	46
	Female	36	44.4	45.25	9.89	45.5
MD (N=13)	Male	09	11.1	49.77	10.74	50
	Female	04	4.9	35.75	15.12	41
VN (N=2)	Male	02	2.4	36	14.12	-
	Female	-	-	-	-	-
CSOM with labyrinthitis (N=1)	Male	01	1.2	-	-	-
	Female	-	-	-	-	-

The present study had 81 participants with vestibular pathologies. They were divided into four groups, namely BPPV, Meniere's disease, vestibular neuritis and CSOM with labyrinthitis. Among 81 participants, 41 were males and 40 were females.

Table 2: Mean, standard deviation, median and interquartile range of various cVEMP parameters in BPPV and Meniere's disease participants

Participants	Parameters	Affected side				Unaffected side			
		Mean	SD	Median	IQR	Mean	SD	Median	IQR
BPPV	P1(in ms)	14.6	1.53	14.4	2.6	12.3	1.65	14.1	2.6
	N1(in ms)	22.05	2.6	21.8	3.4	21.9	2.45	21.7	2.4
	Amp(in µV)	2.7	2.59	1.6	3.6	3.76	2.35	2.9	3.3
MD	P1(in ms)	10.9	1.50	15.5	2.3	13.3	1.95	14.6	1.5
	N1(in ms)	16.13	1.50	23.1	2.7	20.5	1.04	22	1.35
	Amp(in µV)	1.86	2.66	1.2	3.2	4.1	2.40	3.4	4.3

All participants underwent cVEMP test in both their ears. The study included 2 participants with vestibular neuritis. In the affected ear of Participant 1, the P1 latency was 14.2 ms, N1 latency was 23.3 ms, and peak-to- peak amplitude was 3.1 µV. In the unaffected ear of this participant, P1 latency was 13.8 ms, N1 latency was 23.3 ms, and the peak-to-peak amplitude was 2.8 µV. The inter-aural asymmetry ratio was 5.08%. In Participant 2, the P1 latency was 14.8 ms, N1 latency was 25.6 ms, and the peak-to-peak amplitude was 0.3 µV in the affected ear whereas in his unaffected ear, the P1 latency was 16.4 ms, N1 latency was 24.5 ms, and peak-to-peak amplitude was 9.1 µV. The inter-aural asymmetry ratio in this participant was 93.6%. The present study had 1 participant with CSOM with labyrinthitis. There was absent cVEMP response in the affected ear. In the unaffected ear, P1 latency was 13.5 ms, N1 latency was 21.6 ms and peak-to-peak amplitude was 2.8 µV. And the inter-aural asymmetry ratio was 100%.

Table 3: Wilcoxon Signed Rank test of the affected and unaffected ears of BPPV participants in cVEMP

	UP1-AP1	UN1-AN1	UAmp-AAmp
Z	-1.958	-0.145	-2.827
p value	0.050	0.885	0.005

The Wilcoxon signed ranks test was done to compare between the affected and unaffected ears of participants with BPPV. The results revealed no significant ear difference for P1 latency [Z=-1.958, p=0.050] and N1 latency [Z= -0.145, p=0.885]; however, there was a significant difference in the peak-to-peak amplitude [Z= -2.827, p=0.005] between the two ears.

Table 4: Wilcoxon Signed Rank test of the affected and unaffected ears of Meniere's disease participants in cVEMP

	UP1-AP1	UN1-AN1	UAmp-AAmp
Z	-2.106	-0.981	-1.684
p value	0.035	0.326	0.092

The Wilcoxon signed ranks test was also done to compare between the affected and unaffected ears of individuals with Meniere's disease. The results revealed no significant ear difference for N1 latency [Z= -0.981, p=0.326] and peak- to-peak amplitude [Z= -1.684, p=0.092]; however, there was a significant difference between the ears for P1 latency [Z= -2.106, p=0.035].

Table 5: Wilcoxon Signed Rank test of the affected and unaffected ears of BPPV participants in oVEMP

	UN1-AN1	UP1-AP1	UAmp-AAmp
Z	-1.288	-0.566	-2.963
p value	0.198	0.571	0.003

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The Wilcoxon signed ranks test was done to compare between the affected and unaffected ears of individuals with BPPV. The results revealed no significant ear difference for the latencies of N1 [Z= -1.288, p=0.198] and P1 [Z= -0.566, p=0.571]. However, there was a significant ear difference for peak-to-peak amplitude [Z= -2.963, p=0.003].

Table 6: Wilcoxon Signed Rank test of the affected and unaffected ears of Meniere's disease participants in oVEMP

	UN1-AN1	UP1-AP1	UAmp-AAmp
Z	-0.169	-1.866	-0.938
p value	0.866	0.062	0.348

The Wilcoxon signed ranks test was also done to compare between the affected and unaffected ears of individuals with Meniere's disease. The results revealed no significant ear difference for N1 latency [Z= -0.169, p=0.866], P1 latency [Z=-1.866, p=0.062] and peak-to-peak amplitude [Z= -0.938, p=0.348].

DISCUSSION

In our study, we had 65 participants with BPPV. The median latencies of cVEMP in these participants were 14.4 ms and 21.8 ms for P1 and N1 peaks, respectively in their affected ears and 14.1 ms and 21.7 ms, respectively in the unaffected ears. These findings are in agreement with those reported previously (Korres et al., 2011; Karatas et al., 2016; Singh et al., 2014; Singh and Apeksha, 2016).[7-10] they also found a no significant difference in P1 and N1 latencies of cVEMP between the two ears' cVEMP responses in individuals with BPPV. However, these findings contradict the findings of some of the other studies (Singh et al., 2014; Singh and Apeksha, 2016).[9,10] The differences could be attributed to probably the heterogeneity within the population with regards to the source of the origin of the otoconia particles that enter the semicircular canals to produce the symptoms of BPPV. While it is largely accepted that the primary source of otoconia particles is the utricular macula (Brevern et al., 2007; Manzari et al., 2012).[11,12]

In the Meniere's disease group, there were 13 participants. The comparison of latencies between their ears showed a no significant difference in N1 latency; however, there was a significant difference between the ears for P1 latency. These findings are similar to those reported by (Akkuzu et al., 2006),[2] who also found the prolongation of only the P1 latency in the affected ears of the individuals with Meniere's disease.

In terms of the peak-to-peak amplitude of cVEMP, there was no significant ear difference in the participants with Meniere's disease. These findings are in disagreement with the findings of the previous studies (Karatas et al., 2016;).[8] The differences in the findings of the present study from that published previously could be due to small sample size (N=13), and even a smaller number ears with Meniere's disease showing presence of cVEMP. In addition to our data showed the standard deviation to be almost one and half times more than the mean itself. In the Meniere's disease group, there was no significant ear difference in the latencies of N1 and P1 peaks of oVEMP. These findings are in agreement with those reported previously (Zhou et al., 2017).[13]

In the Participant with labyrinthitis, both cVEMP and oVEMP are absent in the affected ear. These findings are similar to those reported in the literature (Moon et al, 2012),[14] However the participant in question had a co-morbid condition of CSOM. It is well known that air-conduction induced in cVEMP and oVEMP are hugely affected and often absent in persons with middle ear problems (Chou et al, 2009).[15] Therefore it would be difficult to point out at the cause of absent responses of cVEMP and oVEMP in this participant.

CONCLUSION

In the present study, the peak-to-peak amplitudes were reduced in both cVEMP and oVEMP in the BPPV patients and the P1 latency of cVEMP was prolonged in Meniere's disease patients. This could provide useful information about the saccule and utricle in individuals with BPPV and Meniere's disease. Based on the findings from this study we concluded that VEMP could be used as a screening test in diagnosis of vestibular pathologies like BPPV, MD, VN, etc. However VEMP parameters alone cannot be used as a sole criteria in the diagnosis. Assigning a clear-cut diagnosis may be difficult in such cases on the basis of VEMP test alone.

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