

Original Article

Studying VEMP in Sudden Sensorineural Hearing Loss

*Mohsen Rajati¹, Mehdi Bakhshaei¹, Ebrahim Naghavi², Faezeh Hoseinnejad³, Hamid Reza Rouhi⁴,
Rahman Movahhed⁴

Abstract

Introduction:

Sudden sensorineural hearing loss (SSNHL) has a prevalence of 10 in 100,000. Viral infections, vascular obstruction and rupture of the intracochlear membranes are supposed to be its most common etiologies. About 40% of patients experience vertigo or imbalance. The VEMP (vestibular evoked myogenic potentials) test is a known approach for detailed study of the labyrinth. The advantage of this test in comparison to other tests is the selected study of sacculus and sacculocochlear pathways.

Materials and Methods:

In this cross sectional study all patients with SSNHL diagnosis were admitted and underwent routine standard treatments and diagnostic tests. Clinical symptoms and paraclinic findings were recorded in especially designed forms and VEMP test was performed on admission.

Results:

Among the 43 cases with sudden sensorineural hearing loss, 14 (32.6%) had vertigo. Thirteen patients (39.2%) out of 43 had a negative (abnormal) VEMP, 6 of which (42.9%) had vertigo, while in the 30 VEMP positive (normal) cases, vertigo was detected in 8 (26.6%).

Discussion:

Saccular dysfunction seems to be an important finding in SSNHL. Although it is more prevalent in the patients with vertigo, it can be found in the non-dizzy cases. VEMP disturbance in SSNHL shows more extensive pathological involvement.

Conclusion:

In SSNHL the pathology isn't limited to the cochlea and even in patients with no vestibular symptoms sacculus might be involved.

Keywords:

Sudden hearing loss, VEMP, Vertigo

Received date: 27 Dec 2010

Accepted date: 24 May 2011

¹Ear, Nose, Throat, Head and Neck surgery Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

²Department of otorhinolaryngology, Faculty of Medicine, Guilan University of Medical Sciences, Rasht, Iran

³Otolaryngologist, Mashhad University of Medical Sciences, Mashhad, Iran

⁴Department of otorhinolaryngology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

***Corresponding author:**

Ear, Nose, Throat, Head and Neck surgery Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
Email: rajatim@mums.ac.ir, Tel: +985118413492

Introduction

Sudden sensorineural hearing loss (SSNHL) is defined as a sensorineural hearing loss of 30 dB or more in at least three contiguous frequencies, which occurs within 3 days most often even in ≤ 12 hours (1,2). Its most common presentation is the unilateral hearing loss at the time of waking up. Other symptoms include ear fullness in the affected ear, vertigo and tinnitus.

The etiology is considered idiopathic in most cases; others include infectious, neoplastic, traumatic, ototoxic, immunologic, vascular, evolutionary and psychological etiologies (3-5). Vascular disorder which results in ischemia and necrosis of the spiral ganglion, rupture of the membranes (i.e. round, oval or Reissner's membrane) which result in the collapse of internal ear compartments and subsequently the degeneration of the organ of Corti, and also viral infection in the endolymphatic structures including the cochlea or spiral ganglion are the suggested hypothesis for the etiopathogenesis of this disease.

Neoplasms are another rare but important etiology for SSNHL. In 10.2% of acoustic neuromas, SSNHL is an initial symptom. So CPA (cerebello-pontine angle) and IAC (internal auditory canal) neoplasms should be ruled out in SSNHL.

Of the predicting factors in SSNHL prognosis the intensity of hearing loss, audiogram pattern, presence of vertigo, patient's age, low discrimination score (SDS) at the time of entrance and the time of treatment initiation can be mentioned.

VEMP test (vestibular evoked myogenic potentials) consists of electromyograms (EMG) with shortened latency periods which are recorded by the superficial electrodes on the contracted Sternocleidomastoid (SCM) muscle during exposure to high intensity noise stimulations. Peripheral vestibular system is considered as the origin of this special response pathway which goes from saccule

to the inferior vestibular nucleus, (the lateral nucleus of (Dieterz) and the lateral vestibulo-spinal tract, accessory nuclei of the eleventh nerve and finally to SCM. Normally there is a cessation in SCM contraction in response to the noise stimulant and it is reported as positive VEMP.

The amplitude of VEMP is influenced by the intensity and frequency of the stimulus and also the level of tonic muscle contraction, whereas the latency period of VEMP is independent from other variables (6).

In comparison to other exams, VEMP is an accurate test in determining the lesion's location. This test can diagnose any abnormal activity of the saccule or the inferior vestibular nerve (7) and is highly sensitive and can show even minor changes in the function of the vestibular system. On the other hand its application is simple and most ABR recording devices can be used for the recording of VEMP. Unlike the ENG test which takes longer than 1-2 hours, the VEMP test could be done in less than an hour and causes less discomfort to the patient (7).

Among the clinical applications of VEMP the following indications could be named: endolymphatic hydropse (Meniere's disease), dehiscence of the superior semicircular canal, acoustic schwannoma, vestibular neuritis, some brainstem disorders, severe and profound hearing loss, enlarged vestibular aqueduct and also bilateral vestibular disorder with an unknown origin (7-11).

In this study we aimed on investigating the progression of a cochlear disorder to the saccule in sudden sensorineural hearing loss patients (SSNHL) with the help of VEMP testing.

Materials and Methods

This is a cross sectional study on evaluating the saccular function with the help of VEMP test in sudden hearing loss cases and the correlation of the results with vestibular symptoms in these patients.

The study population consisted of all patients visiting the ENT clinic of our university hospital, whom were diagnosed with sudden sensorineural hearing loss (SSNHL) from Oct. 2008 to Sept. 2010. The exclusion criteria consisted of patients with a more than two-week history of hearing loss, head trauma, acoustic neuroma or other CNS diseases and also patients under the age of 10 or over 70 years.

All patients affected with SSNHL were admitted to the ENT ward and received standard treatments besides undergoing routine diagnostic tests. All clinical symptoms and paraclinic findings were routinely recorded in specially designed forms. In this study the VEMP test was also performed in addition to other exams at the time of admission.

VEMP was performed with clicks of 0.1ms duration given 5 times per second. The click's intensity was 95dB. If in response to this stimulus an EMG relaxation wave is produced, the test result would be positive (normal) and if no wave is produced it is reported as negative.

Results

Forty three patients, 23 (53.5%) males and 20 (46.5%) females with the mean age of 41.3 yrs. (age range: 16 to 67 yrs.) were met the criteria of this study. The simultaneous involvement of both ears was detected in 3 cases (7%).

Regarding seasonal prevalence, the number of SSNHL cases was 8 (18.6%) in both spring and summer, 13 (30.2%) in autumn and 14 (32.6%) in winter. Of the 43 cases, 14 (32.6%) had vertigo and 20 (46.5%) had tinnitus. Eleven patients (25.6%) had an accompanying disease: diabetes in 6, hypothyroidism in 4 and Takayasu disease in 1 patient. Moreover, in 12 (27.9%) cases a recent viral respiratory infection prior to this disease was reported.

The number of SSNHL cases with mild (24-40 dB), moderate (40-55 dB), moderately severe (55-70dB), severe (70-90dB) and profound (>90 dB) hearing loss were 4 (9%), 6 (14%), 8 (19%), 14 (32%) and 11 (26%), respectively.

The number of cases with a flat audiometric pattern was 16 (37.2%), those with a down-sloping & up-sloping pattern were 8 (18.6%) in each group. Eleven cases (25.6%) were totally deaf with no specific curve pattern.

Among the 43 studied cases 30 (69.8%) had a positive VEMP test and 13 (39.2%) had a negative test.

In the study population in the 13 (39.2%) cases with a negative VEMP response, 6 (42.9%) were affected with vertigo while among the 30 (60.8%) patients with a positive VEMP this number was 8 (26.6%). This correlation was statistically insignificant ($P > 0.05$) (Table and Fig 1).

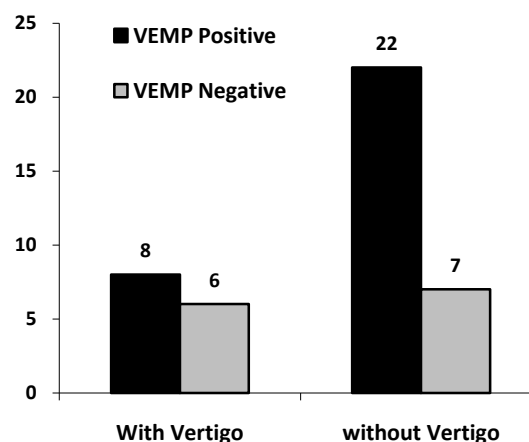


Fig 1: The relation between VEMP result and vertigo

On the other hand from the 14 cases with vertigo, 6 (43%) had a negative VEMP response, and among those 29 patients without vertigo 7 (24%) had a negative VEMP, table 1.

On the other hand, among the 14 cases with tinnitus 8 (57.1%) had a positive

VEMP response and 6 (42.9%) a negative result. This correlation was *not* statistically significant ($P>0.05$) (Table 1).

Also from the 13 negative-VEMP patients, 8 (61.5%) had tinnitus and in the 30 patients with a positive VEMP response, 12 (40%) suffered from this disorder, Table 1.

Table 1: The VEMP test result based on the vertigo and tinnitus symptoms

VEMP response	Positive	Negative
With vertigo	(8) 57.1%	(6) 42.9%
Without vertigo	(22) 75.9%	(7) 24.1%
With tinnitus	(12) 60%	(8) 40%
Without tinnitus	(18) 78.8%	(5) 21.2%

Discussion

The prevalence of sudden sensorineural hearing loss is rising due to environmental factors and mainly life stresses. Although in cases of immediate therapy a 60 to 80% improvement rate could be achieved, regarding the morbidity rate of this disease more researches to reveal its etiology and physiopathology seem necessary.

In routine auditory evaluation tests, the function of the cochlea is evaluated. Considering the integrity of the labyrinth and the anatomic intimate correlation between auditory and vestibular organs, involvement of the entire labyrinth in the disease process seems likely. Whether the saccule, like the cochlea, has been dysfunctional or not should be examined with specific tests, in which case VEMP is a good option. As it is known, the VEMP test records saccule responses to the acoustic stimulus; these responses are independent of the patient's hearing status, meaning that even in severe or profound hearing losses with a healthy saccule, they can be recorded (11). In the recent years, VEMP test has been applied in various diseases including Meniere's disease,

patent superior semicircular canal dehiscence syndrome, eighth cranial nerve schwannoma and brain disorders.

In a study conducted by Zhou et al in Boston University, USA; the VEMP test showed saccular dysfunction in SSNHL patients and their VEMP wave amplitude was reduced while no changes happened in the latency of waves (12).

Wang et al investigated the importance of VEMP and ABR tests in 88 patients with SSNHL; they considered the occurrence of an electrophysiological response as a sign of good prognosis in these two tests (13).

In a similar study by Hong et al on 52 patients with SSNHL but no vertigo, the VEMP test was performed. They had aimed on determining the subclinical involvement of the saccule in such cases. The results of this study showed a higher prevalence of saccule involvement in cases with profound hearing loss in comparison to the other types (despite the absence of vertigo) (14). In the present study subclinical saccule involvement (those with a negative VEMP test) was 24% in cases with no vertigo (7 out of 27).

Iwasaki et al examined 22 SSNHL cases with Caloric and VEMP tests. They detected VEMP test disorder in 17 (77%) whereas Caloric test disorder was also reported in 10 (45%). The authors concluded that in sudden sensorineural hearing loss, saccule involvement is more common than semicircular ducts involvement (15). The 77% of affected cases reported in this study is higher than our results achieved as 39% of cases. It is important to note that they selected the SSNHL cases with vertigo; however this rate is still higher than our results.

Stamatiou et al conducted Caloric and VEMP tests on 86 SSNHL cases. The study cases included patients both with and without vertigo. VEMP test dysfunction was detected in 30.2% and Caloric test dysfunction in 52.3%. This study showed a meaningful difference between the occurrence of vestibular

symptoms and abnormality of these tests (16). Their reported result was close to the 39% of cases obtained in our study.

Moreover, the VEMP test was negative in 43% of SSNHL cases with vertigo and 24% of those without this symptom.

Conclusion

In SSNHL the pathology isn't limited to the cochlea and even in patients with no vestibular symptoms sacculus might be involved. This finding could be a sign of

the saccule's role in the auditory system in addition to the vestibular system.

Acknowledgments

The results presented in this work has been taken from resident's thesis. The authors wish to thank Dr. M. Shakeri, the statistical consultant and Mr. Tale, the audiologist and all Pejvak audiology center staff for their kind assistance in performing this study.

References

1. Wilson WR. The relationship of the herpes virus family to sudden hearing loss: a prospective clinical study and literature review. *Laryngoscope* 1986; 96(8): 870-7.
2. Whitaker S. Idiopathic sudden hearing loss. *Am J Otol* 1980; 1(3): 180-3.
3. Schuknecht HF, Kimura RS, Naufal PM. The pathology of sudden deafness. *Acta Otolaryngol* 1973; 76(2): 75-97.
4. Gussen R. Sudden deafness of vascular origin: a human temporal bone study. *Ann Otol Rhinol Laryngol* 1976; 85(1 Pt 1): 94-100.
5. Simmons FB. Theory of membrane breaks in sudden hearing loss. *Arch Otolaryngol* 1968; 88(1): 41-8.
6. Akin FW, Murnane OD, Proffitt TM. The effects of click and tone-burst stimulus parameters on the vestibular evoked myogenic potential (VEMP). *J Am Acad Audiol* 2003; 14(9): 500-9.
7. Zhou G, Cox LC. Vestibular evoked myogenic potentials: History and overview. *Am J Audiol* 2004; 13(2): 135-43.
8. Jacobson GP, McCaslin DL. The vestibular evoked myogenic potentials and other onomotor evoked potentials. In: Burkard FB, Eggermont JJ, Don M. (editors). *Auditory Evoked potentials*. 1st ed. Baltimore: Williams and Wilkins; 2007: 572-59.
9. Rauch SD, Zhou G, Kujawa SG, Guinan JJ, Herrmann BS. Vestibular evoked myogenic potentials show altered tuning in patients with Menieres disease. *Otol Neurotol* 2004; 25: 333-8.
10. Halmagyi GM, Curthoys IS, Colebatch JG, Aw ST. Vestibular responses to sound. *Ann N Y Acad Sci* 2005; 1039: 54-67.
11. Rosengren SM, Colebatch JG. Vestibular evoked potentials (VsEPs) in patients with severe to profound bilateral hearing loss. *Clin Neurophysiol* 2006; 117(5):1145-53.
12. Zhou G, Kenna MA, Stevens K, Licameli G. Assessment of saccular function in children with sensorineural hearing loss. *Arch Otolaryngol Head Neck Surg* 2009; 135(1): 40-4.

13. Wang CT, Huang TW, Kuo SW, Cheng PW. Correlation between audiovestibular function tests and hearing outcomes in severe to profound sudden sensorineural hearing loss. *Ear Hear* 2009; 30(1): 110-4.
14. Hong SM, Byun JY, Park CH, Lee JH, Park MS, Cha CI. Saccular damage in patients with idiopathic sudden sensorineural hearing loss without vertigo. *Otolaryngol Head Neck Surg* 2008; 139(4): 541-5.
15. Iwasaki S, Takai Y, Ozeki H, Ito K, Karino S, Murofushi T. Extent of lesions in idiopathic sudden hearing loss with vertigo: Study using click and galvanic vestibular evoked myogenic potentials. *Arch Otolaryngol Head Neck Surg* 2005; 131(10): 857-62.
16. Stamatiou G, Gkoritsa E, Xenellis J, Riga M, Korres S. Semicircular canal versus otolithic involvement in idiopathic sudden hearing loss. *J Laryngol Otol* 2009; 123(12): 1325-30.