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Role of videonystagmography and cervical vestibular evoked myogenic potentials in the diagnosis of vestibular migraine

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Zana Abdulrahman Mohammed[1]*

Abstract

Background and objective: Vestibular migraine is widely accepted as a unique disease, although its pathophysiology remains uncertain. When the patient is asymptomatic, vestibular migraine is often challenging to diagnose as its many symptoms overlap with other conditions. This study aimed to assess the role of videonystagmography and cervical vestibular evoked myogenic potentials tests in diagnosing vestibular migraine.

Methods: This study is a descriptive cross-sectional study conducted on 30 patients clinically diagnosed with vestibular migraine in the Audiology Center in Sulaimani City. The study duration was from December 1st, 2018, to June 30th, 2019. The author interpreted magnetic resonance imaging, videonystagmography, and cervical vestibular evoked myogenic potential results.

Results: The patients' mean age was 34.9 years with a high predominance of the female gender. Vertigo was the main complaint of the patients (73.4%) with the recurrent course. A family history of migraine was present in 83.3% of the patients. Only two (6.7%) patients had abnormal findings on the brain magnetic resonance imaging. Videonystagmography examination showed that 40% of the patients had abnormal findings; 20% were abnormal on the left, 16.7% were abnormal on the right, and 3.3% were bilaterally abnormal. The cervical vestibular evoked myogenic potentials test was abnormal for 63.3% of the patients; 43.3% abnormality was on the left side, and 20% was on the right side.

Conclusion: The cervical vestibular evoked myogenic potentials and videonystagmography tests are helpful in the diagnosis of vestibular migraine.

Keywords: Vestibular migraine; Video nystagmography; Cervical vestibular-evoked myogenic potentials.

Introduction

Migraine is a common disorder represented by recurrent throbbing headaches, often one-sided, and an aura infrequently precedes it. The association between vestibular defect and migraine has been suggested and investigated.[1] Besides, vestibular migraine is a specific type of migraine that presents with vestibular symptoms like spontaneous and positional vertigo, dizziness, motion intolerance, phonophobia, tinnitus, photophobia, ataxia, cervicalgia, confusion, and anxiety.[2] It affects 1% of the population.[3] It occurs at all ages, but it is mainly encountered later in life, especially in patients who have already been diagnosed with migraines.[3] Females are affected more frequently than males.[3] Although its exact mechanism is still unknown, different theories have been proposed, like dysfunction of the vestibular -thalamocortical network and cortical spreading depression.[4,5]

Videonystagmography is more valuable than electronystagmography (ENG); it has better capture, stability to observation and resolution, and torsional eye movement recording.[6]

The vestibular-evoked myogenic potential is a short-latency potential initiated by

[1] Neurology Department, Shar Teaching Hospital, Sulaimani, Iraq.
Correspondence: zhanw82@yahoo.com

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sound or vibration to activate the vestibular receptors. It is produced by modulated electromyographic signals either from the inferior oblique muscle in the ocular vestibular-evoked myogenic potential or the sternocleidomastoid muscle in the cervical vestibular-evoked myogenic potential.[7] These reflexes originate from the otolith organs; hence, they are utilized in the evaluation and diagnosis of central and peripheral vestibular disorders.[7] It has been suggested that incorporating the vestibular-evoked myogenic potential test holds promise for improving vestibular migraine diagnosis.[8] Therefore, the current study aimed to assess the role of videonystagmography and cervical vestibular evoked myogenic potentials cervical vestibular-evoked myogenic potential tests for diagnosing vestibular migraine.

Methods

This descriptive cross-sectional study was performed on 30 patients who visited the Audiology Center in Sulaimani from December 1st, 2018, to June 30th, 2019. All patients were suspected of vestibular migraine and presented to the Audiology Center in Sulaimani.

Approval was taken from the Audiology Center's administration in Sulaimani, and oral informed consent was taken from patients.

The inclusion criteria were patients aged ≥18 years and clinically diagnosed with vestibular migraine, according to the International Headache Society's diagnostic criteria for vestibular migraine.

The exclusion criteria were patients with other primary headaches, other vestibular disorders, ear surgery, other neurological disorders, and psychiatric disorders.

The International Headache Society's diagnostic criteria for vestibular migraine are shown in Table 1.[9]

The demographic features of the patients, including age, gender, and occupation, were collected. The main complaint, characteristics, course, provokers of headache, accompanying symptoms, and family history of vestibular migraine were recorded. Besides, magnetic resonance imaging (MRI)"SIMENS" was performed in Shar Hospital, and the author interpreted the results. Also, videonystagmography findings include characteristics and spontaneous nystagmus, gazing, saccade, smooth pursuit, optokinetic, head-shaking, and positional tests, and cervical vestibular -evoked myogenic potential findings, including characteristics, right and left P1 latency, right and left n1 latency, right and left P1-n1 latency or amplitude, were recorded. Both the videonystagmography (Synapsys, France) and cervical vestibular-evoked myogenic potential (Interacoustic Eclipse 'EP15' Interacoustics, Denmark) were done in the Audiology Center, and also the author interpreted the results. The ICHD-3 Beta criteria of vestibular migraine 15 were used for diagnosing the patients.

The patients' data were analyzed using Microsoft Excel software and the statistical package for the social sciences (version 23). Also, descriptive statistics were used, including frequencies, means, and standard deviation (SD).

Table 1 Diagnostic criteria of vestibular migraine

Criteria	Details
A.	At least five attacks with vestibular symptoms of the intensity of moderate to severe, which last five to seventy-two hours
B.	Previous or current migraine history with or without aura based on the International Classification of Headache Disorders (ICHD)
C.	One or more features of migraine with about 50% of the vestibular attacks: 1- Headache with at least two of the following features: pulsating quality, one-sided position, aggravation by routine physical activity, and moderate to severe pain intensity 2- Phonophobia or photophobia 3- Visual aura
D.	Not better accounted for other ICHD or diagnosis vestibular

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Results

The mean ± SD of patients' age was 34.9±8.2 years; 70% of them were in the age of 30 years or more (Table 2). The female to male ratio was (6.5:1). The majority of the occupation of the patients (80%) were housewives (Table 2).

Vertigo was the leading complaint (73.4%) in the patients, and most of the complaint course was recurrent (90%). Besides, the duration was primarily minutes to days (93.4%). Also, positional changes such as turning in bed were the common provoker (83.3%), as shown in Table 3.

Table 2 Sociodemographic characteristics of patients

Variable		No.	%
Age (year)	<20	1	3.3
(Mean ± SD = 34.9 ± 8.2)	20-29	8	26.7
	30-39	13	43.3
	≥40 years	8	26.7
	Total	30	100
Gender	Male	4	13.3
	Female	26	86.7
	Total	30	100.0
Occupation	Housewife	24	80.0
	Public servant	1	3.3
	Free works	3	10.0
	Student	2	6.7
	Total	30	100.0

Table 3 Complaint characteristics of vestibular migraine patients

Variable		No.	%
Main complaint	Vertigo	22	73.4
	Unsteadiness	1	3.3
	Light-headedness	6	20.0
	Near-faint feelings	1	3.3
Complaint course	Recurrent attacks	27	90.0
	Continuous	3	10.0
Duration in most of the episodes	Less than a minute	1	3.3
	Minutes to days	28	93.4
	Longer than a week	1	3.3
Complaints provoked by	Positional changes such as turning in bed	25	83.3
	Looking up	1	3.3
	Not provoked	2	6.7
	Positional changes such as turning in bed and looking up	2	6.7
Total		30	100.0

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Common accompanying symptoms were tinnitus and aural pressure (63.4%), followed by tinnitus (20%). All the patients had a headache during the complaint for more than half of the attacks and lasted more than four hours if not treated (Table 4).

Common complaint characteristics (33.3%) were pulsating quality, moderate to severe intensity, and aggravation by physical activity, followed by unilateral location, pulsating quality, moderate or severe intensity, and aggravation by physical activity (30%). However, the common headache characteristics (80%) were photophobia and phonophobia (Table 5).

Table 4 Complaint characteristics of vestibular migraine patients

Variable		No.	%
Accompanying symptoms during complaints	Tinnitus and aural pressure	19	63.4
	Tinnitus	6	20.0
	Aural pressure	4	13.3
	No symptoms	1	3.3
Headache during complaints		30	100.0
Frequency of headache	< half of the attacks	1	3.3
	> half of the attacks	29	96.7
Do the headache attacks last more than four hours if not treated	Yes	28	93.3
	No	2	6.7
Total		30	100.0

Table 5 Common complaint and headache characteristics of vestibular migraine patients

Variable	No.	%
Common characteristics		
Pulsating quality and aggravation by physical activity	3	10.0
Pulsating quality, moderate to severe intensity, and aggravation by physical activity	10	33.3
Unilateral location and pulsating quality	2	6.7
Unilateral location, pulsating quality, moderate or severe intensity, and aggravation by physical activity	9	30.0
Unilateral location, Pulsating quality, and Moderate or severe intensity	2	6.7
Moderate or severe intensity and aggravation by physical activity	3	10.0
Unilateral location, moderate or severe intensity, and aggravation by physical activity	1	3.3
Headache characteristics		
Photophobia and phonophobia	24	80.0
Photophobia, phonophobia, nausea, and vomiting	6	20.0
Total	30	100.0

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A family history of migraine and a history of chronic diseases was present in 83.3% and 6.7% of the patients. Also, symptoms that started first were mainly (86.6%) headaches (Table 6).

The brain MRI examination showed normal T1, T2, and DW parameters. However, the FLAIR images showed two (6.7%) abnormal findings in the patients' brain MRIs (Table 7).

The videonystagmography examination showed 40% abnormal findings, which were mostly (36.7%) unilaterally abnormal. Spontaneous nystagmus was negative in all the patients, and most of the tests, like gazing, saccade, smooth pursuit, and optokinetic tests, were normal for all the patients. However, the head shaking and positional tests were abnormal for 33.3% and 40% of patients, respectively (Table 8).

The cervical vestibular-evoked myogenic potential test was abnormal in 63.3% of the patients; 63.3% were abnormal unilaterally. The mean right p1 latency and the mean right n1 latency were16.3 and 23.8, respectively, while the mean left p1 latency and mean left n1 latency were 16.8 and 23.7, respectively (Table 9).

Table 6 Family and clinical history of vestibular migraine patients

Variable		No.	%
Family history of migraine	Yes	25	83.3
	No	5	16.7
History of chronic disease	Yes	2	6.7
	No	28	93.3
Symptoms start first	Vertigo	2	6.7
	Headache	26	86.6
	Both symptoms start	2	6.7
Total		30	100.0

Table 7 MRI findings of vestibular migraine patients

Variable		No.	%
T1	No	30	100.0
T2	No	30	100.0
FLAIR	No	28	93.3
	Cortical lesion	1	3.3
	Small periventricular	1	3.3
DW	No	30	100.0
MRI note	Normal MRI	28	93.3
	Abnormal MRI	2	6.7
Total		30	100.0

DW = Diffusion weighted; FLAIR = Fluid-attenuated inversion recovery

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Table 8 Videonystagmography findings of vestibular migraine patients

Variable		No.	%
Videonystagmography	Normal	18	60.0
	Abnormal	12	40.0
Videonystagmography characteristics	Normal	18	60.0
	Abnormal left	6	20.0
	Abnormal right	5	16.7
	Abnormal bilateral	1	3.3
Spontaneous nystagmus	Negative	30	100.0
Gazing test	Normal	30	100.0
Saccade test	Normal	30	100.0
Smooth pursuit	Normal	30	100.0
Optokinetic test	Normal	30	100.0
Head shaking test	Normal	20	66.7
	Abnormal	10	33.3
Positional test	Normal	18	60.0
	Abnormal	12	40.0
Total		30	100.0

Table 9 Cervical vestibular evoked myogenic potential findings of vestibular migraine patients

Variable		No.	%
Cervical vestibular-evoked myogenic potential	Normal	11	36.7
	Abnormal	19	63.3
Cervical vestibular-evoked myogenic potential characteristics	Normal	11	36.7
	Abnormal left	13	43.3
	Abnormal right	6	20.0
Right P1 Latency (Mean ± SD = 16.3±1.4)	Normal	30	100.0
Right n1 Latency (Mean ± SD = 23.8 ± 2.5)	Normal	28	93.3
	Abnormal	2	6.7
Right n1-p1 Latency (Mean ± SD = 7.4 ± 2.1)			
Right n1-p1 Amplitude (Mean ± SD = 0.8 ± 0.6)			
Right inter-aural (Mean ± SD = 0.28 ± 0.18)			
Left P1 Latency (Mean ± SD = 16.8 ± 2.1)	Normal	27	90.0
	Abnormal	3	10.0
Left n1 Latency (Mean ± SD = 23.7 ± 2.5)	Normal	28	93.3
	Abnormal	2	6.7
Left n1-p1 Latency (Mean ± SD = 6.9 ± 2)			
Left n1-p1 Amplitude (Mean ± SD = 0.65 ± 0.56)			
Left inter-aural (Mean ± SD = 0.28 ± 0.18)			
Total		30	100.0

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Discussion

Since the 19th century, the associations between dizziness and migraine have been well described. The international criteria for vestibular migraine diagnosis are recurrent vestibular symptoms accompanying migraine history, a temporal association between them, and the exclusion of other causes of vestibular symptoms.[10]
The current study showed that the mean age of patients with vestibular migraine was 34.9 years. While vestibular migraine can develop at any age, it usually affects persons with a long-established migraine history.[11] It is usually diagnosed with an average 8.4 years delay after the first migraine onset.[12]
In the current study, the female to male ratio was 6.5:1, and this finding is consistent with the results found by Morganti et al.[13] A study in Brazil showed that 94.1% of the patients were females as compared to the 5.9% males.[13] Also, the study of Filippopulos et al.[14] performed in Germany found female gender as a common risk factor for dizziness and vertigo among adolescents. The current study found that vertigo was the common complaint of vestibular migraine with mainly recurrent attacks; in contrast, all the studied patients had a headache. Similarly, the studies of Luzeiro et al.[15] in Portugal stated that vertigo could arise in the context of a headache attack (after, occurring with, or preceding) or between attacks, and the relationship of time with the attacks is highly varied.
The current study also showed that most episodes' duration was minutes to days for 93.4% of the patients, and positional changes like turning in bed were the common provoker (83.3%). Vertigo episodes had a variable duration from seconds (3.3%), minutes to days (93.4%), and rarely to weeks (3.3%). By definition, they must last minutes to hours or days (usually <72 hours), collectively being considered one attack. Vertigo must be moderate to severe in intensity, interfere with daily activities, and limit or prevent them. Patients frequently identify the trigger factor of the migraine.[15]
The current study found that tinnitus and aural pressure (63.4%) were the common accompanying symptom of vestibular migraine. The common complaint characteristics of vestibular migraine were photophobia and phonophobia (80%). These findings align with the study of Murofushi et al.,[16] who showed common headache characteristics of vestibular migraine as photophobia and phonophobia. The study by Teggi et al.[17] in Italy consistently reported that the main characteristics of vestibular migraine headaches were photophobia and phonophobia. Family history was the leading risk factor for vestibular migraine in the current study. This finding coincides with the results of the study of Beh et al.[18] in the USA, which reported that family history was the common risk factor for vestibular migraine. The vestibular migraine symptom that started first in the current study was principally the headache. This finding is similar to the study results of Sugaya et al.[19] in Japan, which documented that headache symptom started first in vestibular migraine.
The current study also showed only two (6.7%) abnormal MRI findings; one had a cortical lesion, and the other had small periventricular lesions. These findings are close to the study results performed by Lepcha et al.[20] in India, which noticed that abnormal MRI findings were present in 24%, and the typical finding was hyperintensities of the deep white matter of the brain.
In the current study, a videonystagmography examination of patients showed that 40% had abnormal findings; 20% were abnormal on the left side, 16.7% were abnormal on the right side, and 3.3% were abnormal bilaterally. These findings are similar to the study performed by Mostafa et al.[21] in Egypt, which showed that 40% of patients were diagnosed with vestibular migraine.[21] However, they concluded that combining a careful history with clinical

examination, MRI, videonystagmography, and Doppler studies decreases the number of undiagnosed patients and increase the diagnosis of possible central lesions.[21] The current classifications of the International Headache Society (ICHD-3 beta version) 15 and the Bárány Society for Neuro-Otology 40 in 2013 are used to group the symptoms. According to the mentioned classifications, at least the attacks must last five minutes. Headaches, ear symptoms (e.g., hearing loss, ear pressure), and visual aura occur in about 50% of the patients.[22] The study by Mostafa et al.[21] in Egypt found that videonystagmography tests are an excellent diagnostic tool for differentiating central and peripheral vestibular lesions. The sensitivity of the videonystagmography increased with the inclusion of positional tests to the oculomotor tests.[12]

In some patients, it is challenging to differentiate between central positional vertigo and benign paroxysmal positional vertigo. Nystagmus and apogeotropic nystagmus in multiple plains must arouse suspicion of the central nervous system lesion. Ischemia of anterior circulation may cause chronic vertigo. However, central vestibular vertigo can be because of the dysfunction or excitation of various central nervous system tissues, including the vestibular cortex.[12]

The current study showed that the cervical vestibular-evoked myogenic potential test was abnormal for 63.3% of the patients; 43.3% was abnormal on the left side, and 20% was abnormal on the right side. This finding is close to the study performed by Khalil et al.[23] in Egypt, which found that cervical vestibular-evoked myogenic potential findings were abnormal in 75% of clinically diagnosed vestibular migraine. Another Egyptian study carried out by Mohamed et al.[24] reported that cervical vestibular-evoked myogenic potential is a proper complementary method for testing vestibular function in vestibular migraine. The most frequent feature in vestibular migraine is the decreased cervical vestibular-evoked myogenic potential amplitude or absent response.[24] The saccule and or the sacculo-collic pathway are affected in vestibular migraine, with more peripheral vestibular dysfunction in vestibular migraine patients.[24] Further, Gozk et al.[25] performed a study investigating ocular vestibular-evoked myogenic potentials in migraine and showed that the mean latencies of N1 and P1 were drastically longer, and N1–P1 amplitudes were lower than those in the control group.[25] A complete absence of the response was also less observed in 18.6% of patients.[25] Zuniga et al.[26] found that vestibular migraine patients had reduced cervical vestibular-evoked myogenic potentials and ocular vestibular-evoked myogenic potentials amplitudes relative to controls.

Conclusion

The cervical vestibular-evoked myogenic potential and videonystagmography are helpful in the diagnosis of vestibular migraine.

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Competing interests

The author declares that he has no competing interests.

References

1. Furman JM, Balaban CD. Vestibular migraine. Ann N Y AcadSci. 2015;1343(1):90–6. http://doi.org/10.1111/nyas.12645
2. Maslovara S, Butković SS, Pajić-Penavić I, Alkhamis T, Vešligaj T, Soldo A. Vestibular migraine considering new diagnostic criteria. Neurologia Croatica. 2014;63(1-2):11–8.
3. Sohn JH. Recent Advances in the Understanding of Vestibular Migraine. Behav Neurol. 2016;2016:1 801845. http://doi.org/10.1155/2016/1801845
4. Russo A, Marcelli V, Esposito F, Corvino V, Marcuccio L, Giannone A, et al. Abnormal thalamic function in patients with vestibular migraine. American Acad Neurol. 2014;82(23):2120–6. http://doi.org/10.1212/WNL.0000000000000496
5. Stankewitz A, Schulz E, May A. Neuronal correlates of impaired habituation in response

to repeated trigemino-nociceptive but not to olfactory input in migraineurs: an fMRI study. Cephalalgia. 2013;33(4):256–65. http://doi.org/10.1177/0333102412470215
6. Mohamed E. Predictors of central vestibular disorders from videonystagmography tests. Egyptian J Otolaryngol. 2016;32(3):202. https://doi.org/10.4103/1012-5574.186534
7. Fife TD, Satya-Murti S, Burkard RF, Carey JP. Vestibular evoked myogenic potential testing: Payment policy review for clinicians and payers. Neurol Clin Pract. 2018;8(2):129–34. http://doi.org/10.1212/CPJ.0000000000000430
8. Zaleski A, Bogle J, Starling A, Zapala D, Davis L, Wester M, et al. Vestibular Evoked Myogenic Potentials in Patients with Vestibular Migraine. Otol Neurotol. 2015;36(2):295–302. http://doi.org/10.1097/MAO.0000000000000665
9. Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia. 2013;33(9):629–808. http://doi.org/10.1177/0333102413485658
10. Hazzaa N, El Mowafy S. Clinical features of vestibular migraine in Egypt. Egyptian J Ear Nose Throat Allied Sci. 2016;17(1):17–21. http://doi.org/10.1016/j.ejenta.2015.12.002
11. Dieterich M, Obermann M, Celebisoy N. Vestibular migraine: the most frequent entity of episodic vertigo. J Neurol. 2016;263(S1):82–9. http://doi.org/10.1007/s00415-015-7905-2
12. Dieterich M, Obermann M, Celebisoy N. Vestibular migraine: the most frequent entity of episodic vertigo. J Neurol. 2016;263(Suppl 1):S82–9. http://doi.org/10.1007/s00415-015-7905-2
13. Morganti LO, Salmito MC, Duarte JA, Bezerra KC, Simões JC, Ganança FF. Vestibular migraine: clinical and epidemiological aspects. Braz J Otorhinolaryngol. 2016;82(4):397–402. http://doi.org/10.1016/j.bjorl.2015.06.003
14. Filippopulos FM, Albers L, Straube A. Vertigo and dizziness in adolescents: Risk factors and their population attributable risk. PLoS One. 2017;12(11):e0187819.http://doi.org/10.1371/journal.pone.0187819
15. Luzeiro I, Luís L, Gonçalves F, Pavão Martins I. Vestibular Migraine: Clinical Challenges and Opportunities for Multidisciplinarity. Behav Neurol. 2016;2016:6179805. http://doi.org/10.1155/2016/6179805
16. Murofushi T. Vestibular migraine (migraine-associated vertigo). Equilibrium Research. 2018;77(6):525–31. https://doi.org/10.3757/jser.77.525
17. Teggi R, Colombo B, Albera R, Libonati GA, Balzanelli C, Caletrio AB, et al. Clinical Features of Headache in Patients with Diagnosis of Definite Vestibular Migraine: The VM-Phenotypes Projects. Front Neurol. 2018;9:395. https://doi.org/10.3389/fneur.2018.00395
18. Beh SC, Masrour S, Smith SV, Friedman DI. The Spectrum of Vestibular Migraine: Clinical Features, Triggers, and Examination Findings. Headache. 2019;59(5):727–40. http://doi.org/10.1111/head.13484
19. Sugaya N, Arai M, Goto F. Is the Headache in Patients with Vestibular Migraine Attenuated by Vestibular Rehabilitation? Front Neurol. 2017;8:124. http://doi.org/10.3389/fneur.2017.00124
20. Lepcha A, Tyagi AK, Ashish G, Augustine AM, Balraj A. Audiovestibular and radiological findings in patients with migrainous vertigo. Neurol Asia. 2015;20(4):367–73.
21. Mostafa BE, Kahky AO, Kader HM, Rizk M. Central vestibular dysfunction in an otorhinolaryngological vestibular unit: incidence and diagnostic strategy. Int Arch Otorhinolaryngol. 2014;18(3):235–8. http://doi.org/10.1055/s-0034-1370884
22. Walther LE. Current diagnostic procedures for diagnosing vertigo and dizziness. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2017;16:Doc02. http://doi.org/10.3205/cto000141
23. Khalil LH, Hazzaa NM, Nour AA. Vestibular migraine: A correlation study between clinical findings and vestibular evoked myogenic potentials (VEMPs). Egyptian J Ear Nose Throat Allied Sci. 2016;17:11–6. http://doi.org/10.1016/j.ejenta.2015.05.005
24. Mohamed ES, Ahmed MAR, Said EAF. Role of cervical vestibular-evoked myogenic potentials testing in vestibular migraine. Egyptian J Ear Nose Throat Allied Sci. 2015;16:139–44. https://doi.org/10.1016/j.ejenta.2015.04.001
25. Gozk E, Erdal N, O¨ Zkarakas H. Ocular vestibular evoked myogenic potentials in patients with migraine. Acta Neurol Belg. 2010;110:321–4.
26. Zuniga MG, Janky KL, Schubert MC, Carey JP. Can vestibular evoked myogenic potentials help differentiate Me'nie're disease from vestibular migraine? Otolaryngol Head Neck Surg. 2012;146(5):788–96. http://doi.org/10.1177/0194599811434073