Case Report
Iranian Journal of Otorhinolaryngology, Vol.36(5), Serial No.136, Sep-2024

Masseteric Vestibular Evoked Myogenic Potentials in Vestibular Neuritis: A Case Series

Anjana Rajesh[1], *Anuj Kumar Neupane[1]

Abstract

Introduction:

Masseteric VEMPs have been effective in evaluating a diverse spectrum of vestibular conditions associated with various brainstem pathologies, but they have rarely been explored among patients with vestibular neuritis.

Case Report:

The current investigation included a case series highlighting mVEMP responses in addition to cVEMPs and oVEMPs in three patients diagnosed with vestibular neuritis. In the study, all three patients were found to have absent or diminished responses in cVEMPs, oVEMPs, and mVEMPs.

Conclusions:

In the present study, the distinctions in cVEMP and oVEMP findings can be attributed to the involvement of inferior and superior vestibular nerve respectively. Furthermore, mVEMP presents a more intricate scenario, both in terms of its genesis and outcomes. This emphasizes the clinical relevance of mVEMP when used in combination with cVEMP and oVEMP, rather than as a substitute for the other VEMPs.

Keywords: CVEMP, MVEMP, OVEMP, Vestibular neuritis, Tone bursts.

Received date: 28 Jan 2024
Accepted date: 20 Jul 2024

***Please cite this article**; Rajesh A, Neupane AK. Masseteric Vestibular Evoked Myogenic Potentials in Vestibular Neuritis: A Case Series. Iran J Otorhinolaryngol. 2024:36(5):619-625. Doi: 10.22038/ijorl.2024.77538.3598*

[1]*Bharati Vidyapeeth (Deemed to be University) School of Audiology and Speech Language Pathology, Pune.*
[*]***Corresponding Author:***
Bharati Vidyapeeth (Deemed to be University) School of Audiology and Speech Language Pathology, Pune.

Introduction

Vestibular neuritis, also known as vestibular neuronitis, likely stems from inflammation of the vestibular component of the eighth cranial nerve, manifesting in symptoms such as vertigo and nausea, often associated with preceding or concurrent viral infections. Typically characterized as a benign and self-limiting condition, vestibular neuritis can endure for a period ranging from several days to weeks (1), with reported incidence rates of approximately 48.49% (2).

Vestibular neuritis is predominantly characterized by two major subtypes, with total vestibular neuritis comprising 39.9% of the total incidence, while superior vestibular neuritis accounts for around 48.1%. In contrast, the less common subtype, inferior vestibular neuritis, is observed in only 12.03% of all cases (3). As a result, more pronounced abnormalities in ocular vestibular evoked myogenic potentials (oVEMPs) have often been reported compared to cervical VEMPs (cVEMPs) (4). However, this is rarely explored in relation to masseteric VEMP (mVEMP). mVEMPs are biphasic potentials characterized by a positive peak at 11 msec and a negative peak at 21 msec (5). These potentials are known to assess the vestibulo-trigeminal pathway. Notably, mVEMPs have proven to be effective in evaluating a range of vestibular conditions linked to multiple brainstem pathologies (6-8).

Moreover, in-depth investigations covering all three types of VEMPs, namely cVEMP, oVEMP, and mVEMP, in conditions such as amyotrophic lateral sclerosis (8), multiple sclerosis (9), and Parkinson's disease (10), have provided better insights into understanding brainstem lesions. In the specific context of vestibular neuritis, Deriu et al. (10) utilized mVEMPs in a case study, revealing the presence of the detectable p16-n21 component associated with the cochlear response and the absence of the P11 peak on the affected side. However, the study did not extensively explore various parameters of mVEMPs.

Additionally, the study noted the absence of cVEMP responses on the same side. These limited findings on vestibular neuritis suggest the necessity for a comprehensive evaluation encompassing all three VEMPs - cVEMP, oVEMP, and mVEMP- which may provide a deeper understanding of the underlying pathophysiology of vestibular pathways and unveil opportunities for meaningful clinical applications. Consequently, a case series focusing on mVEMP responses in three individuals with vestibular neuritis is discussed in the present article (11). Each of these patients underwent a comprehensive VEMP assessment, consisting of cVEMP, oVEMP, and mVEMP.

Case Report

The present case series was performed as per the Declaration of Helsinki and authorized by the institutional ethics committee. Written informed consent was obtained from each participant in the study.

Patient 1 -Total vestibular neuritis in both ears

A 25-year-old female was referred to the department with a complaint of vertigo and imbalance persisting for the past 7-8 days. She had a high fever lasting 8-9 days, followed by episodes of vertigo. No complaints of hearing difficulties, ear pain, sensation of blockage, sound intolerance, tinnitus, or any other neurological problems were mentioned in the case history.

She started experiencing dizziness about a week ago, typically occurring upon waking in the morning, and it was characterized by sudden blackouts, a tendency to fall to the right, a sensation of pressure in the head, swaying, and the perception of surrounding objects as stable but with her head in motion. In addition, the patient suffered from frequent headaches.

An MRI reported no significant abnormalities in the neuro-parenchyma. Otoscopy confirmed intact bilateral tympanic membranes. Hearing evaluation revealed normal hearing sensitivity in both ears.

Videonystagmography tests, including the saccade test, optokinetic test, smooth pursuit test, and gaze test, did not suggest any central involvement. The Interacoustics Eclipse EP-25 device was utilized to record VEMP responses employing a 500Hz tone burst at 95 dBnHL. In the test, the cVEMPs were found to have good morphology and latencies, but reduced amplitudes in both ears, indicating bilaterally affected functioning of the sacculo–collic reflex pathway (Table 1).

Table 1: Comparative illustrations of mVEMP, cVEMP, and oVEMP responses in three patients with vestibular neuritisalongside normative reference values from published literature.

Types of VEMP	*Parameters*	Patient 1		Patient 2		Patient 3		Individuals with normal hearing	
		Right	Left	Right	Left	Right	Left	Right	Left
mVEMP	P1 latency	13.00	13.00	Absent	15.00	Absent	15.33	12.25*	12.91*
	N1 latency	21.00	28.33	Absent	20.67	Absent	21.33	21.25*	21.12*
	P1-N1 amplitude	0.33	0.63	Absent	0.45	Absent	0.13	1.11*	1.05*
cVEMP	P1 latency	15.33	14.67	Absent	13.33	Absent	Absent	14.67**	15.33**
	N1 latency	24.00	21.33	Absent	21.67	Absent	Absent	25.00**	26.67**
	P1-N1 amplitude	0.46	0.15	Absent	0.23	Absent	Absent	1.34**	1.37**
oVEMP	N1 latency	Absent	14.67	Absent	Absent	Absent	Absent	12.60***	12.60***
	P1 latency	Absent	20.00	Absent	Absent	Absent	Absent	17.50***	17.50***
	N1-P1 amplitude	Absent	0.12	Absent	Absent	Absent	Absent	0.97 ***	0.97 ***

Note: Normative data for mVEMP, cVEMP, and oVEMP responses were sourced from the research conducted by *Vignesh et al., (12); **Neupane & Lodha (13) and ***Shahnaz & David (14) respectively

Further, oVEMPs showed absent N1P1 responses in the right ear, along with good morphology and latencies but reduced amplitudes in the left ear (Table 1), implying bilaterally affected functioning of the utriculo-ocular reflex pathway. With regard to mVEMP, responses with good morphology and latencies but reduced amplitudes (Table 1), were observed in both ears (Fig.1).

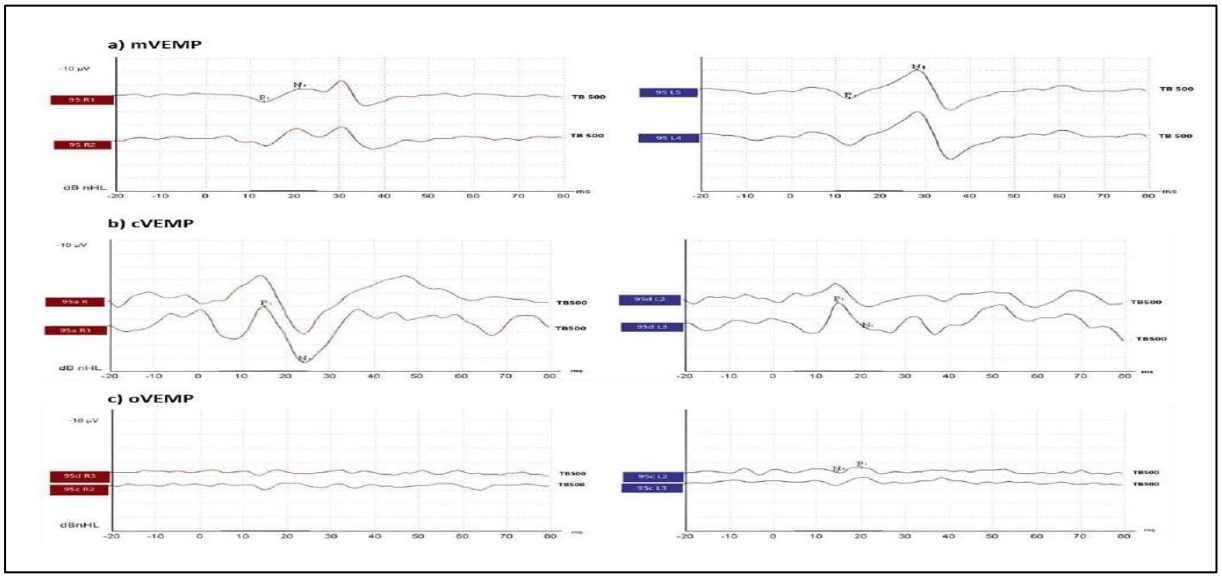

Fig 1: Illustration of the mVEMP, cVEMP, and oVEMP responses for 500 Hz tone burst in the first patient with vestibular neuritis

Patient 2 - Total vestibular neuritis in both ears

A 50-year-old female presented with a complaint of vertigo persisting for the past 10 days, accompanied by nausea and occasional tinnitus in the right ear. The patient had a history of viral infection approximately 15 days before her current symptoms. Upon otoscopic examination, bilateral tympanic membranes were found to be intact. Hearing assessment indicated minimal hearing loss in both ears. No central pathology was detected through a battery of videonystagmography tests. The cVEMP response was found to be present with fair morphology and normal latencies but reduced amplitudes in the left ear (Table 1). In contrast, the right ear showed absent responses, suggesting impaired functioning of the sacculo-collic reflex pathway bilaterally. oVEMP was found to be absent in both ears, suggesting impaired functioning of the utriculo-ocular reflex pathway. mVEMP responses were absent in the right ear, and present in the left ear with fair morphology and latencies, but reduced amplitudes (Table 1), suggestive of bilateral impairment of the vestibulo-trigeminal pathway (Figure 2).

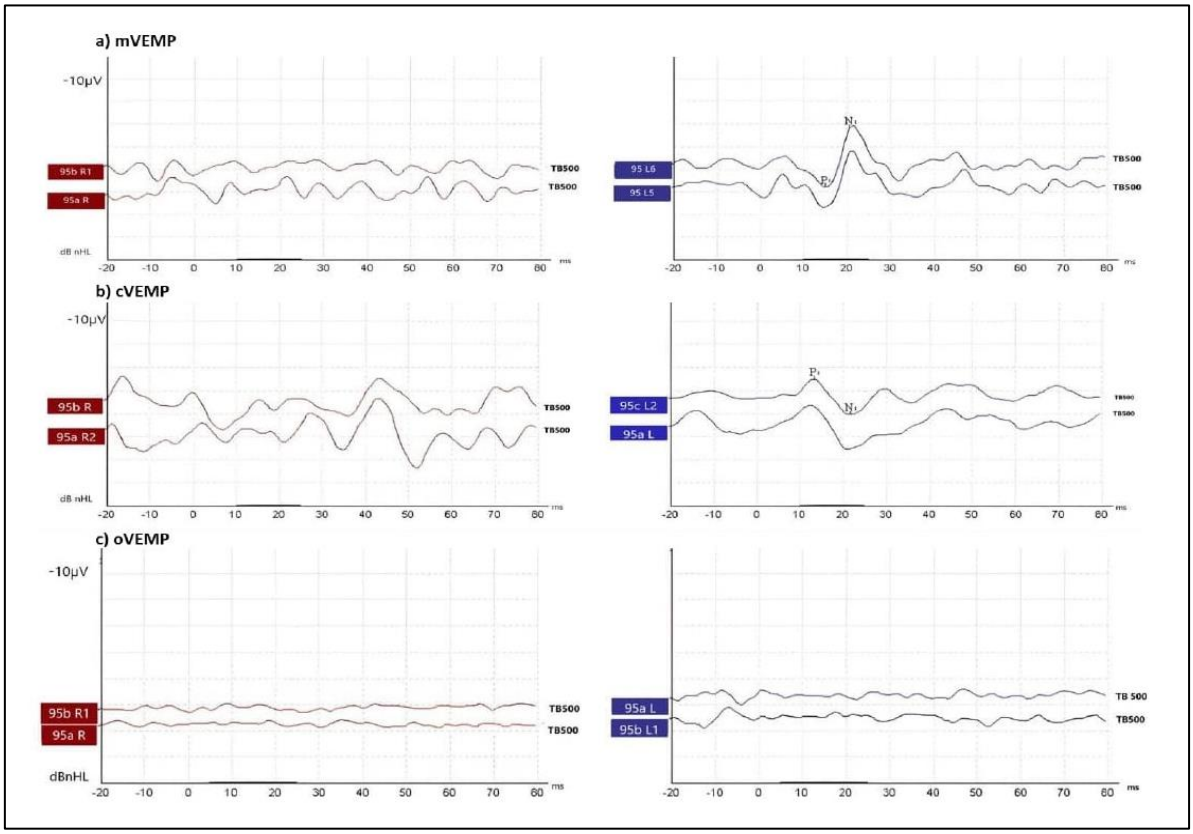

Fig 2: Illustration of the mVEMP, cVEMP, and oVEMP responses for 500 Hz tone burst in the second patient with vestibular neuritis

Patient 3 - Total vestibular neuritis in both ears

A 49-year-old female was referred with a persistent complaint of head pressure, accompanied by a continuous sensation of swaying and spinning throughout the entire day over the past 2-3 weeks. The patient also reported experiencing ear pain and nausea during this same period. She mentioned a recent history of a common cold that preceded the sensation of dizziness. Further, she noted similar episodes of dizziness approximately 4-5 months earlier. Upon evaluation, her tympanic membranes were found to be intact, with normal hearing sensitivity in both ears. Videonystagmography tests suggested no central involvement of the condition. Further, responses were found to be absent in both ears, demonstrating impaired functioning of the sacculo-collic reflex pathway (Figure 3). In addition, oVEMP exhibited absent responses, indicating bilaterally affected functioning of the utriculo-ocular reflex pathway (Figure 3).

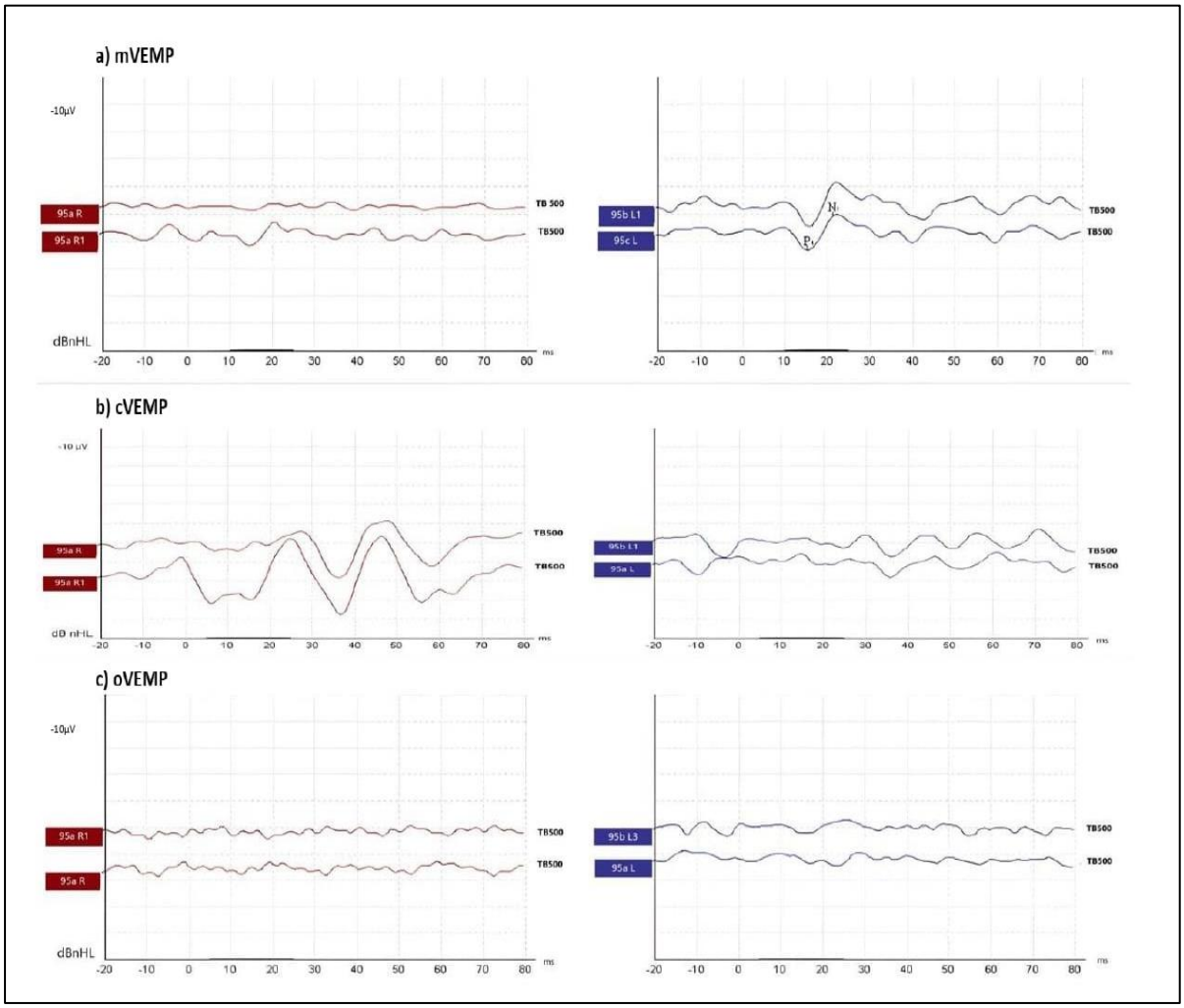

Fig 3: Illustration of the mVEMP, cVEMP, and oVEMP responses for 500 Hz tone burst in the third patient with vestibular neuritis

The mVEMP responses were absent in the right ear, whereas in the left ear, the responses were present with fair morphology, normal latencies, and reduced amplitude (Table 1).

Discussion

The current study presented a case series involving a comprehensive VEMP assessment, encompassing cVEMP, oVEMP, and mVEMP in three patients diagnosed with total vestibular neuritis in both ears. All patients exhibited impaired cVEMP and oVEMP responses, ranging from total absence to reduced peak-to-peak amplitude in one or both ears. Anatomically, cVEMP originates from the saccule and receives innervation from the inferior vestibular nerve, whereas oVEMP arises from the utricle and is innervated by the superior vestibular nerve (3,11). Furthermore, mVEMPs are understood to have saccular origins, receiving innervation from the vestibular nerve (5,6). Interestingly, in the study, a greater impact was observed on oVEMPs rather than cVEMPs, which was consistent with prior findings, indicating that the superior vestibular nerve is more susceptible to inflammation as compared to the inferior segment due to anatomical differences (15-18). Furthermore, the current study, for the first time, examined various parameters of mVEMPs in conjunction with cVEMPs and oVEMPs among three patients with vestibular neuritis.

In the first case study, the patient exhibited an absent oVEMP response in the right ear, and a considerably diminished response in the left ear. Regarding the cVEMP response, abnormally reduced amplitudes were observed for both ears. A similar result was obtained for the mVEMPs, where both ears had abnormal

responses. In the second case study, the patient had completely absent oVEMP responses in both ears. However, while an abnormal cVEMP response was present in the right ear, no response was obtained in the left ear, aligning with the mVEMP findings. Both cases highlight a consistent observation: the mVEMP results mirrored those of the cVEMPs, implying a potential shared vestibular receptor mechanism between them (19,20). In the third case study, both oVEMP and cVEMP responses were absent in both ears. However, an abnormal mVEMP was evident in the left ear,with delayed latency observed.This finding mirrored the delayed mVEMP latency observed in the right ear of the second case study. It is worth noting that mVEMPs encompass both cochlear and vestibular origins. Specifically, the initial component, termed P11-N15 or the vestibulo-masseteric response, is known to originate from the vestibular system. In contrast, the subsequent component, known as P16-N21 or the acoustic-masseteric response, arises from the cochlear system (5,20). Given this understanding, the delayed latency observed in the second and third patients with vestibular neuritis aligns with the responses attributed to a cochlear origin, especially considering that both patients reported normal or near-normal hearing sensitivity. This observation resonates with findings by Deriu et al. (10), where individuals with unilateral vestibular neuritis retained the auditory component of mVEMP (p16-n21 wave) while exhibiting an absence of the vestibular component (p11-n15). However, since such delays were absent for both ears in the first patient, one might infer a relatively milder involvement in the vestibular segment for this individual.

Conclusion

In conclusion, the current study distinctly illustrates varying degrees of dissociation among cVEMP, oVEMP, and mVEMP responses in patients diagnosed with vestibular neuritis. In all three case reports with total vestibular neuritis, where both the superior and inferior vestibular nerves were affected, mVEMP was also impacted to varying degrees. The distinctions in cVEMP and oVEMP can be attributed to the involvement of the inferior or superior vestibular nerve, while mVEMP presents a more complex scenario in terms of both its origin and findings. This underscores its clinical relevance, not as a substitute for cVEMP and oVEMP but as a complement to their findings. Hence, the inclusion of mVEMP in addition to cVEMP and oVEMP can offer valuable insights into the pathophysiology of the individual with vestibular neuritis.

Acknowledgements

The authors express their gratitude to all the volunteers who participated in the study and extend their appreciation to Mrs. Munmun Dutta for her support during the manuscript preparation.

References

1. Smith T, Rider J, Cen S, Borger J. Vestibular neuronitis. In StatPearls. StatPearls Publishing; 2019. Available from: https://europepmc. org/ article/ nbk/nbk549866

2. Mandalà M, Salerni L, Ferretti F, Bindi I, Gualtieri G, Corallo G et al. The incidence of vestibular neuritis in Italy. Front Neurol 2023; 14:1177621.

3. Lee JY, Park JS, Kim MB. Clinical characteristics of acute vestibular neuritis according to involvement site. Otol Neurotol 2019;40(6):797-805.

4. Fetter M, Dichgans J. Vestibular neuritis spares the inferior division of the vestibular nerve. Brain 1996;119(3),755–763.

5. Deriu F, Tolu E, Rothwell JC. A short latency vestibulomasseteric reflex evoked by electrical stimulation over the mastoid in healthy humans. J Physiol 2003;553(1):267-79.

6. De Natale ER, Ginatempo F, Paulus KS, Pes GM, Manca A, Tolu E et al. Abnormalities of vestibular-evoked myogenic potentials in idiopathic Parkinson's disease are associated with clinical evidence of brainstem involvement. Neurol Sci 2015;36(6):995-1001.

7. Magnano I, Pes GM, Pilurzi G, Cabboi MP, Ginatempo F, Giaconi E et al. Exploring brainstem function in multiple sclerosis by combining brainstem reflexes, evoked potentials, clinical and MRI investigations. Clin Neurophysiol 2014; 125(11): 2286-2296.

8. Liu X, Zhang S, Huang X, Zhang Y, Fan D. Vestibular evoked myogenic potentials and their clinical utility in patients with amyotrophic lateral sclerosis. Clin Neurophysiol 2019;130(5):647-654.

9. Sangu SV, Rangappan MB, Singh NK, Rajalakshmi K. Usefulness of masseter vestibular evoked myogenic potentials in identifying brainstem dysfunction among individuals with multiple sclerosis. Int J Audiol 2022; 62(7):635-643.

10. Deriu F, Ortu E, Capobianco S, Giaconi E, Melis F, Aiello E et al. Origin of sound-evoked EMG responses in human masseter muscles. J Physiol 2007;580(1):195-209.
11. Strupp M, Bisdorff A, Furman J, Hornibrook J, Jahn K, Maire R et al. Acute unilateral vestibulopathy/vestibular neuritis: diagnostic criteria. J Vestib Res 2022;32(5):389-406.
12. Lodha V, Neupane AK. Multifrequency narrowband chirp evoked cervical vestibular myogenic potentials: evaluation of responses in normal-hearing young adults. Am J Audiol 2022;31(4):1191-1201.
13. Shahnaz N, David EA. Normal values for cervical and ocular vestibular-evoked myogenic potentials using EMG scaling: effect of body position and electrode montage. Acta Oto-Laryngol 2021;141(5):440-448.
14. Vignesh SS, Singh NK, Rajalakshmi K. Tone burst masseter vestibular evoked myogenic potentials: normative values and test–retest reliability. J Am Acad Audiol 2021;32(5):308-314.
15. Ochi K, Ohashi T, Watanabe S. Vestibular-evoked myogenic potential in patients with unilateral vestibular neuritis: abnormal VEMP and its recovery. J Laryngol Otol 2003;117(2):104-108.
16. Gianoli G, Goebel J, Mowry S, Poomipannit P. Anatomic differences in the lateral vestibular nerve channels and their implications in vestibular neuritis. Otol Neurotol 2005;26(3):489-494.
17. Shin BS, Oh SY, Kim JS, Kim TW, Seo MW, Lee H et al. Cervical and ocular vestibular-evoked myogenic potentials in acute vestibular neuritis. Clin Neurophysiol 2012;123(2):369-375.
18. Taylor RL, McGarvie LA, Reid N, Young AS, Halmagyi GM, Welgampola MS. Vestibular neuritis affects both superior and inferior vestibular nerves. Neurology 2016;87(16):1704-1712.
19. De Natale ER, Ginatempo F, Paulus KS, Pes GM, Manca A, Tolu E et al. Abnormalities of vestibular-evoked myogenic potentials in idiopathic Parkinson's disease are associated with clinical evidence of brainstem involvement. Neurol Sci 2015;36(6):995-1001.
20. Deriu F, Tolu E, Rothwell JC. A sound-evoked vestibulomasseteric reflex in healthy humans. J Neurophysiol 2005;93(5):2739-51.