

# The Status of Cervical Vestibular Evoked Myogenic Potentials in Patients with Cervical Discopathy and Different Types of Vertigo

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## Abstract

**Objective:** This research study aims to assess the status of cervical vestibular evoked myogenic potentials (cVEMP) in patients diagnosed with cervical discopathy and experiencing different types of vertigo. Cervical discopathy is a common condition characterized by disc degeneration and herniation in the cervical spine. Vertigo, a symptom of vestibular dysfunction, can be caused by various factors including cervical discopathy. However, the relationship between cervical discopathy and different types of vertigo remains unclear. **Design:** The study will recruit a sample of patients diagnosed with cervical discopathy, and presenting with different types of vertigo. The cVEMP test will be conducted to evaluate the vestibular function specifically related to the cervical disc status. The cVEMP test involves measuring the muscular responses of the sternocleidomastoid muscle in response to auditory stimuli. **Result:** The primary outcomes of this study include the assessment of cVEMP parameters such as peak-to-peak amplitudes and latencies in patients with cervical discopathy and various types of vertigo. These parameters will be compared with a control group of individuals without cervical discopathy or vertigo. Additionally, the study will explore potential correlations between cVEMP findings and clinical symptoms and characteristics related to cervical discopathy. **Conclusion:** The results of this research will provide valuable insights into the vestibular function associated with cervical discopathy and different types of vertigo. The findings may contribute to the understanding of the pathophysiology of vertigo in patients with cervical discopathy and help develop targeted management strategies. Ultimately, this study aims to improve the diagnosis and treatment of patients experiencing vertigo associated with cervical spine disorders.

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**Keywords:** cervical vestibular evoked myogenic potentials, cVEMP, cervical discopathy, vertigo, vestibular dysfunction

### Key points

- Cervical discopathy refers to the degenerative changes that occur in the cervical spine and are associated with symptoms such as neck stiffness, radiculopathy, and vertigo.
- cVEMP is the extraction of the information from the inner ear vestibular portion by the recording of induced sternocleidomastoid muscle mechanoreceptors potentials.
- Among patients with cervical discopathy, benign peripheral vertigo is more frequently observed compared to cervical vertigo, making it the most common type of vertigo in this population
- The study findings indicated that the presence or absence of cervical disc pathology did not show any statistically significant difference in cVEMP results.
- The use of cVEMP for assessing peripheral vertigo seems to be applicable regardless of the presence or absence of cervical disc pathology.

### Introduction

Cervical spondylosis and cervical disc herniation are highly prevalent degenerative diseases affecting the cervical spine. In certain instances, they can lead to myelopathy, thereby elevating the potential for significant disability. Key manifestations of these conditions encompass neck pain, stiffness, radiculopathy, and symptoms specific to the affected segment of the spinal cord.<sup>1</sup>

Cervical vestibular evoked myogenic potentials (cVEMP) provide an objective approach to extracting information about the vestibular portion of the inner ear through the stimulation of the sternocleidomastoid muscle. cVEMP is elicited by delivering alternating 500 Hz tone bursts via air conduction and is directly recorded from the sternocleidomastoid muscle mechanoreceptors.<sup>2</sup> This response originates from a reflex circuit that begins in the saccule and proceeds to the ipsilateral vestibular nuclei, ultimately reaching the ipsilateral spinal accessory nerve nuclei.<sup>3</sup> Abundant manuscripts could be found about cervical vertigo and cervical disc pathologies.<sup>4,5</sup> On the other hand the effect of cervical disc pathologies on cVEMP in patients that have noncervical vertigo remains scarce.

The aim of this present study is to investigate the prevalence and the types of peripheral vertigo in patients with cervical hernia and to consider the difference in the cVEMP results of the vertigo patients according to cervical disc status

### Material and Methods

#### Subjects

Between January 2021 and July 2022 thirty-three patients with different diagnoses of peripheral vertigo enrolled in this study. Written informed consent was obtained from the patients. The study design and reporting followed the guidelines set forth by the EQUATOR network for prospective studies.

After taking medical records, all patients with vertiginous symptoms underwent detailed ear nose and throat physical examination. The most common peripheral vertigo diagnosis were; benign paroxysmal positional vertigo (BPPV), vestibular migraine, semicircular canal dehiscence syndrome. Benign paroxysmal positional vertigo diagnosed with head thrust, rotating chair and dix-hallpike tests. Vestibular migraine diagnosis was

by the criteria of at least five episodes with vestibular symptoms of moderate or severe intensity, lasting five minutes to seventy-five hours, current or previous history of migraine, and one or more migraine features with at least 50% of the vestibular episodes.<sup>6</sup> Semicircular canal dehiscence syndrome was diagnosed with thin slice petrous temporal tomography in the patients with complaints of hearing loss, vertigo and/ or pulsatile tinnitus.

All the patients were checked for the pain that radiates through the ear, neck, arm and shoulder with a gait and imbalance and the numbness of the shoulder and arm. Any of the mentioned complaints were recorded when the patient underwent a cervical MRI.

The cervical VEMP (cVEMP) procedure was started with skin preparation by using an alcohol swap. Three electrodes (active, reference and ground) were placed. The active surface electrode was placed at the skin, approximately to the sternocleidomastoid muscle middle part. The upper sternum was the reference electrode location. The forehead was the ground electrode location.

The unilateral air conducted alternating 500 Hz tone bursts was applied by using ER3A-insert earphones. (Etymotic Research, Elk Grove Village, IL, USA.) The initial stimulus intensity was 85 dBnHL and increased incrementally to 95 dBnHL and 105 dBnHL. Electromyography signals were identified, amplified (5000X), filtered (Blackman gating function bandpass 10-1500 Hz) and recorded. The calculation of the interaural difference (IAD) ratio was made by dividing the inter-ear difference of p1-n1 interamplitude by the sum of the p1-n1 interamplitude of both ears. (<sup>7,8</sup>)

## Statistical Analysis

Statistical analysis made by STATA SE 17 software (Copyright 1985-2021 StataCorp LLC StataCorp 4905 Lakeway Drive College Station, Texas 77845 USA). Mean±standard deviation is the expression of continuous data. Non-normal data were converted into logarithmic form and compared with the Mann-Whitney U test. The comparison of variables was performed by the independent student T-Test, p values under <0,05 considered statistically significant. This study has been approved by Local Committee of Ethics at the University XXX.

Conflict of Interest : None

## Results

33 patients 20 female, 13 male. Age  $51.51 \pm 15.67$  (min 21- max 85) Most common peripheric vertigo etiology left benign paroxysmal positional vertigo (bppv), right bppv and migratuar vertigo. (Table 1)

Table 1: The distribution of different types of peripheral vertigo among the study population

Diagnosis	Frequency	Percentage (%)
Left BPPV	19	57,5
Right BPPV	3	9
Migretuary vertigo	3	9
Left semicircular canal dehiscence	3	9
Left Horizontal BPPV	2	6,5
Vestibular neuritis	1	3
Anterior BPPV	1	3
Right semicircular canal dehiscence	1	3

Cervical hernia was found 21 of 33 patients. All of the patients with cervical hernia had multiple level of cervical discopathies. Most common locations of cervical hernia were c5-c6 (22 of 33 patients ( c4-c5 21 of 33 patients) ), c6-c7 (21 of 33 patients) and Table 2 shows the cervical hernia status of vertigo patients with different diagnoses.

Table2 : Cervical Hernia Status Among Different Types of Vertigo

	Cervical Hernia Status	Cervical Hernia Status	Cervical Hernia Status
Diagnosis	Positive	Negative	Total
Left BPPV	13	6	19
Right BPPV	2	1	3
Migretuary vertigo	2	1	3
Left semicircular canal dehiscence	2	1	3
Left Horizontal BPPV	1	1	2
Vestibular neuritis	1	0	1
Anterior BPPV	0	1	1

The interaural difference ratio among different decibels is displayed at Table 3. The comparison of the IRA VEMP results did not show any statistical significance according to the presence of the cervical hernia on both patients.

Table 3 : The interaural difference ratio among cervical hernia status.

	Cervical Hernia	Cervical Hernia	
Decibel value of IAD(DB)	Positive	Negative	P value
85	37.29±25.45	31.42±21.68	0.48
95	35.95±23.84	32.31±21.26	0.65
105	27.79±15.67	35.31±29.36	0.41

## DISCUSSION

The function of the otolithic and inferior vestibular nerves can be tested through the use of cervical vestibular evoked myogenic potentials (cVEMP). The accessory nerve, which innervates the sternocleidomastoid (SCM) muscle, is responsible for transmitting the signals from these nerve, leading to the production of cVEMP waves. While these waves are typically observed in healthy individuals, some elderly subjects may not produce an observable response.<sup>9</sup>

Many clinician tend to attribute vertiginous symptoms in patients with a cervical hernia to cervical vertigo, but a recent study suggests otherwise.<sup>10</sup> Consistent with our own findings, this study has also identified benign paroxysmal positional vertigo (BPPV) as the most prevalent type of peripheral vertigo among patients with cervical degenerative myelopathies. Benign paroxysmal positional vertigo (BPPV) has also been declared as the predominant peripheral vertigo subtype among patients diagnosed with cervical spondylosis.<sup>11,12</sup>

The findings of the study indicate that the majority of patients with cervical hernias who experience vertiginous symptoms are actually suffering from benign paroxysmal positional vertigo (BPPV). This is a noteworthy observation, as it implies that the root cause of vertigo in these patients may not be directly linked to the hernia itself, but instead attributed to an underlying disturbance within the inner ear.<sup>12</sup> It has been hypothesized that abnormal movement of the cervical vertebrae resulting from the hernia may affect the inner ear.<sup>13</sup> This underscores the criticality of accurate diagnosis and appropriate treatment of cervical hernias to mitigate the occurrence of BPPV-related symptoms.

Based on our findings, there was no observable statistical difference in cVEMP results with respect to the presence or absence of cervical hernia. Cervical myopathies also thought to be a factor that changes the myogenic potentials of the muscles of the neck.<sup>14,13</sup> From this perspective, we anticipated observing modifications in cervical vestibular-evoked myogenic potential (cVEMP) results among patients with cervical hernia. This contradiction could be attributed to the possibility that cervical hernias may exclusively impact

the cervical rootlets.. Affection of cVEMP may rather be attributed to pathologies that result in compression of the vestibular nucleus or the pathway through the spinal accessory nerve nuclei.<sup>15</sup> In addition to our results, a previous report has been observed that when addressing disc pathologies that occur at multiple levels, surgical interventions lead to varying degrees of improvement in vertigo symptoms..<sup>16</sup> This research involved assessing patients with vertigo caused by multiple degenerated cervical discs, both before and after surgical treatment, using subjective tests like the Visual Analog Score (VAS) and the Cervical Vertigo Evaluation Score (CVES)

A similar methodology with our study had similar results with our findings.<sup>17</sup> The study was limited in its scope as it solely enrolled patients diagnosed with cervical disc herniation and excluded those with peripheral vertigo symptoms. Our study, in contrast, investigated vertigo patients with reference to their specific cervical pathology status.

Limitations were the population is relatively small for the different diagnosis of the peripheral vertigo. Only air-conductive type of tone bursts was utilized. Therefore, conductive type of hearing loss was an exclusion criteria. Given these limitations, further research with a larger sample size is necessary to confirm and validate our findings.

The present study's findings indicate that the occurrence of cervical disc herniation does not strongly relate to the different types of peripheral vertigo that patients experience. Moreover, cWEMP results may not be notably influenced by cervical herniation in patients with peripheral vertigo.

## REFERENCES

1. Nakashima H, Yukawa Y, Suda K, Yamagata M, Ueta T, Kato F. Abnormal findings on magnetic resonance images of the cervical spines in 1211 asymptomatic subjects. *Spine (Phila Pa 1976)* . 2015;40(6):392-398. doi:10.1097/BRS.0000000000000775
2. Yang L, Yang C, Pang X, et al. Mechanoreceptors in Diseased Cervical Intervertebral Disc and Vertigo. *Spine (Phila Pa 1976)* . 2017;42(8):540-546. doi:10.1097/BRS.0000000000001801
3. Długaiczek J. Evidence-based diagnostic use of VEMPs : From neurophysiological principles to clinical application. *HNO* . 2020;68(Suppl 2):69-78. doi:10.1007/S00106-019-00767-2
4. Peng B. Cervical Vertigo: Historical Reviews and Advances. *World Neurosurg* . 2018;109:347-350. doi:10.1016/J.WNEU.2017.10.063
5. Devaraja K. Approach to cervicogenic dizziness: a comprehensive review of its aetiopathology and management. *Eur Arch Otorhinolaryngol* . 2018;275(10):2421-2433. doi:10.1007/S00405-018-5088-Z
6. Lempert T, Olesen J, Furman J, et al. Vestibular migraine: Diagnostic criteria (Update): Literature update 2021 \* Consensus document of the Bárány Society and the International Headache Society. *J Vestib Res* . 2022;32(1):1. doi:10.3233/VES-201644
7. Rosengren SM, Colebatch JG, Young AS, Govender S, Welgampola MS. Vestibular evoked myogenic potentials in practice: Methods, pitfalls and clinical applications. *Clin Neurophysiol Pract* . 2019;4:47. doi:10.1016/J.CNP.2019.01.005
8. Ochi K, Ohashi T, Nishino H. Variance of vestibular-evoked myogenic potentials. *Laryngoscope* . 2001;111(3):522-527. doi:10.1097/00005537-200103000-00025
9. Murofushi T, Kaga K. Vestibular evoked myogenic potential: Its basics and clinical applications. *Vestib Evoked Myogenic Potential Its Basics Clin Appl* . 2009;1-112. doi:10.1007/978-4-431-85908-6/COVER
10. Kadanka Z, Kadanka Z, Jura R, Bednarik J. Vertigo in patients with degenerative cervical myelopathy. *J Clin Med* . 2021;10(11):2496. doi:10.3390/JCM10112496/S1
11. Kadanka Z, Kadanka Z, Jura R, Bednarik J. Vertigo in patients with degenerative cervical myelopathy. *J Clin Med* . 2021;10(11):1-12. doi:10.3390/jcm10112496

12. Yang TH, Xirasagar S, Cheng YF, Kuo NW, Lin HC. Association of Cervical Spondylosis With Peripheral Vertigo: A Case–Control Study. *Laryngoscope* . 2021;131(2):E625-E630. doi:10.1002/lary.28715
13. Vasaghi-Gharamaleki B, Naser Z. Predicting the risk of hearing impairment following the cervical spine diseases by measuring the cervical range of movements: A pilot study. *Basic Clin Neurosci* . 2017;8(5):413-418. doi:10.18869/NIRP.BCN.8.5.413
14. Khan A, Khan Z, Bhati P, Hussain ME. Influence of Forward Head Posture on Cervicocephalic Kines-thesis and Electromyographic Activity of Neck Musculature in Asymptomatic Individuals. *J Chiropr Med* . 2020;19(4):230-240. doi:10.1016/J.JCM.2020.07.002
15. Prabhu P, Anish A, Vijayan D, Shiju A, S P S, Sreenivas R. Audio-Vestibular Findings in an Adult With Arnold–Chiari Malformation. *J Hear Sci* . 2020;10(4):85-90. doi:10.17430/jhs.2020.10.4.8
16. Ercan S, Baloglu M. Multi-Level Cervical Disc Degeneration and Vertigo. *Arq Bras Neurocir Brazilian Neurosurg* . 2022;41(04):e311-e315. doi:10.1055/s-0042-1749369
17. Kastanioudakis I, Saravakos P, Zigouris A, Ragos V, Reichel O. Anterior cervical disc fusion does not affect the presence of cervical vestibular-evoked myogenic potential. *J Int Adv Otol* . 2017;13(3):368-373. doi:10.5152/iao.2017.3659