

Unilateral Vestibular Hypofunction in an Adolescent: Case Report and Literature Review

Mirjana Grebenar Čerkez^{1,2}, Željka Laksar Klarić^{1,2}, Jelena Kovačević^{1,3}, Darija Birtić^{1,2}

¹Faculty of Medicine Osijek, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia ²Clinical Hospital Center Osijek, Osijek, Croatia, ³Institute of emergency medicine of the Vukovar-Srijem County, Vinkovci, Croatia

Correspondence: *dr.kovacevic.jelena@gmail.com*; Tel.: + 385 32 300501; Fax: 385 32 300500

Received: August 3 2024; **Accepted:** September 10 2024

Abstract

Objective – The report presents a case of an adolescent girl with vertigo resulting from unilateral vestibular hypofunction, diagnosed after extensive pediatric and otorhinolaryngological evaluations. **Case Report** – A seventeen-year-old female adolescent sought medical assistance at the pediatric emergency hospital service on several occasions within one year due to feelings of weakness and darkened vision occurring during abrupt standing, exposure to heat, and stress. Symptoms were initially attributed to school obligations, low blood pressure, and the menstrual cycle. After an episode that also involved a brief loss of consciousness, an extensive neurological evaluation was conducted, excluding epileptogenic causes. Subsequent diagnostic procedures included evoked visual potential tests, psychological assessments, laboratory blood tests, thyroid hormone assays, and *Borrelia burgdorferi* serology, all yielding normal results. Finally, otorhinolaryngological examinations were performed, including pure tone audiometry, tympanometry, video head impulse tests, videonystagmography, and vestibular evoked myogenic potential tests. These tests indicated symptoms arising from unilateral labyrinthine hypofunction of the inner ear. The patient underwent vestibular rehabilitation, resulting in symptom resolution and confirmed functional recovery. **Conclusion** – Diagnosing vertigo in adolescence is challenging, as impaired balance can manifest as a symptom of various diseases. Presentation with atypical symptoms for peripherally caused balance disorders complicates diagnosis. Otorhinolaryngologists and audio-vestibular diagnosticians play pivotal roles in establishing accurate diagnoses.

Key Words: Vestibular Hypofunction ■ Adolescent ■ Vertigo ■ Vestibular Rehabilitation.

Introduction

Vertigo is a balance disorder characterized by a strong illusion of movement in space. It can stem from dysfunction in various organ systems, including otological, neurological, vascular and ocular (1). Prevalence in children and adolescents ranges from 0.4% to 15% (2), with a higher prevalence observed among female adolescents (3-5). Establishing an etiological diagnosis in the pediatric population is challenging, as vertigo can be part of a complex of symptoms associated with viral and bacterial infections, central nervous system disorders, cardiovascular diseases, and intracranial

tumors. Additionally, the incidence of somatoform, psychological, and psychiatric disorders during this life stage further complicates diagnosis. Clinical presentations and symptoms in adolescents differ significantly from those in adults, often manifesting as weakness, malaise, heat waves, chest pressure, headache, syncope, and a sensation of falling, among others. Acute episodes of vertigo in adolescents are primarily managed by pediatric neurologists and cardiologists.

Diagnostic procedures typically include various serological tests, electrocardiography, electroencephalography, radiological imaging, magnetic resonance imaging of the brain, and extensive

laboratory tests. Typically, only after comprehensive pediatric evaluation are other specialists involved in diagnostics. However, this approach may result in delayed diagnosis of acute peripheral vestibular lesions (6). The management of vertigo in adolescents necessitates a multidisciplinary approach from the outset of evaluation to timely establish an etiological diagnosis and initiate appropriate treatment. The aim of the report is to point out the problem of balance disorders in adolescents and the importance of a multidisciplinary approach with an emphasis on the earlier inclusion of an otolaryngologist in the diagnostic procedure.

Case Report

A seventeen-year-old female patient accompanied by her mother sought medical assistance several times over the course of a year at the pediatric emergency hospital service due to experiencing feelings of weakness, headaches, and darkened vision upon abrupt standing, exposure to heat, and stress. These symptoms were initially attributed to school obligations, low blood pressure, and the menstrual cycle. The last episode also involved a brief loss of consciousness, prompting hospitalization at the pediatric neurology department for further evaluation. The patient's personal history revealed no chronic diseases, prior acute respiratory infections, psychoactive substance abuse, alcohol use, or head trauma. She was born from the first, controlled, normal pregnancy, delivered at term vaginally, with a birth weight of 3850 g, a birth length of 51 cm, and an Apgar score of 10/10. As a newborn, she had torticollis, which was successfully treated with physiotherapy. Between the ages of one and three, she was hospitalized several times for urinary and intestinal infections. At the age of 12, she underwent an appendectomy due to appendicitis, and she had a history of chickenpox. She denied any tick bites.

During hospitalization, the patient's SpO₂ was 98%, pulse was 100/min, and blood pressure was 117/79 mm Hg. Neurological examination revealed no signs of facial or tongue paresis, with normal bulbomotor function, no diplopia,

normal tactile sensation, and slight swaying in the Romberg position. Multi-slice computed tomography of the brain yielded normal results, and laboratory blood tests were within the normal range. Awake and sleep-deprived electroencephalography showed regular patterns without specific paroxysmal elements. *Borrelia burgdorferi* serology was negative. Psychological testing indicated that the patient was a socially desirable female adolescent with above-average non-verbal intellectual abilities. Visual evoked potential tests produced normal results bilaterally. Magnetic resonance imaging of the brain and cervical spine using a 3 Tesla device revealed no abnormalities. Echocardiography demonstrated trivial mitral valve insufficiency without affecting cardiac function.

Considering that the extensive diagnostic evaluation did not determine the etiological cause of the symptoms, an otorhinolaryngologist was consulted for further evaluation. This included pure-tone audiometry, which revealed normal hearing at 10 dB bilaterally, along with normal tympanometry results showing a type A curve. The Video Head Impulse Test (vHIT) demonstrated a vestibulo-ocular reflex threshold of 60 ms for the right lateral semicircular canal at 0.89 +/- 0.06 and for the left semicircular canal at 0.95 +/- 0.02. Videonystagmography revealed vestibular asymmetry, with unilateral weakness of 24% to the right and a directional preponderance of 14% to the left. Additionally, a Vestibular Myogenic Evoked Potential test was conducted, with cervical vestibular evoked myogenic potentials indicating an interaural asymmetry ratio of 35% on the right side, suggesting a lesion of the inferior branch of the right vestibular nerve.

The patient was instructed in vestibular physical therapy for unilateral peripheral vestibular hypofunction. After two months of vestibular rehabilitation, the patient was symptom-free. The recovery of vestibular function was confirmed through follow-up vestibular diagnostics. Control videonystagmography demonstrated vestibular symmetry with unilateral weakness of 10% to the left and a directional preponderance of 4% to the left. Control

vestibular evoked myogenic potential tests indicated interaural symmetry.

Discussion

The causes of vertigo in adolescents are mostly similar to those in adults, although some studies have shown specific differences (7). The incidence of vertigo increases after the age of 10, correlating with hormonal changes, particularly pronounced in females (8). Prevalence increases until the age of 15 and remains stable from 15 to 18 years old (2-7). According to literature data, 14% of adolescents have experienced at least one episode of vertigo, with 4% experiencing at least three episodes (7). The vestibular system undergoes evolution throughout life and is considered fully mature, corresponding to that of an adult, by the age of 16 (9). The late functional development of the vestibular system alters somatosensory and visual control of balance at this age, leading to common disorders such as kinetosis and an increased incidence of balance disorders. Besides the pathophysiological changes contributing to balance disorders, external factors such as elevated stress, sleep deprivation, increased incidence of migraine headaches associated with hormonal changes, muscular pain in the cervical and shoulder area, and irregular and inadequate nutrition also play a role in vertigo during adolescence (10, 11). Hence, the constant change in the vestibular system, different functional pathways involved in adolescent behavior, altered somatosensory control, and external factors collectively exacerbate symptoms of vertigo in adolescents (11). Predominant symptoms include headache (51%), nausea (8%), and vomiting (2%), mostly associated with changes in body and head position during standing up and lying down.

According to literature data, the most common causes of peripheral vertigo in adolescents are vestibular migraine, persistent postural-perceptual vertigo, and benign paroxysmal positional vertigo (12). Vestibular migraine often manifests during puberty but can also occur during childhood, reported by both genders, with a higher incidence

in females (13, 14). It is considered the most frequent cause of vertigo in adolescents. Studies have identified the presence of estrogen receptors in the stria vascularis and spiral ligament of the inner ear, supporting the theory that estrogen fluctuation can influence inner ear homeostasis and regulation of endolymphatic content and concentrations of cations and anions (15). Clinical presentation is similar to that in adults, except that headache is usually bilateral in adolescents.

Diagnosis of vestibular migraine may be challenging due to overlapping symptoms with other disorders such as kinetosis, exacerbation of persistent postural-perceptual dizziness, functional vertigo, and anxiety (15, 16). Vertigo episodes typically last from around 5 minutes to 72 hours, with provoking factors often including the menstrual cycle and sleep deprivation. Symptoms are intense, hindering daily activities. Otoneurological examination and audiovestibular evaluation are necessary for diagnosis. Prevention strategies may include dietary changes such as avoiding coffee, chocolate, and processed meat. If prevention is unsuccessful, therapy at this age typically involves cognitive-behavioral measures and rarely pharmacotherapy (17).

Benign Paroxysmal Positional Vertigo (BPPV) is often found in adolescents due to increased sports activity, which can trigger symptoms (18). Apart from positional causes, symptoms may arise after head trauma or surgical procedures on the head and ear. Specific tests such as the Dix-Hallpike test and video head impulse test, or simply the head impulse test (1), should always be performed in adolescents presenting with vertigo symptoms. If BPPV symptoms are frequent, they may progress to vestibular migraine later in adulthood (19).

Persistent Postural-Perceptual Dizziness (PPPD) is one of the most common causes of chronic vertigo in the pediatric and adolescent population, with a prevalence of 7.3% (20). It is characterized by hypersensitivity to one's own movements and those of nearby objects, typically occurring during changes in body position, standing, sitting, or changes in eyesight direction without a

sense of spinning (20). Symptoms persist over a longer period, negatively impacting quality of life, school achievement, concentration, and attention. Diagnosis can be challenging due to the absence of characteristic spinning sensation and its coexistence with various mental disorders such as anxiety, depression, and phobias. Diagnosis involves collaboration with an audiologist, psychologist, and psychiatrist. Treatment at this age includes vestibular rehabilitation, various cognitive-behavioral techniques, and, in difficult cases, pharmacotherapy (20, 21).

As mentioned earlier, diagnosing peripheral vertigo in adolescence is challenging. Detailed otoneurological examination and vestibulological tests are relied upon to confirm or rule out its existence. Otoneurological examination investigates the occurrence of diplopia or nystagmus, nystagmus direction, and its characteristics (1). Balance tests include the Romberg test and Unterberger's step test for detecting dysfunctional labyrinth in peripheral vertigo (22). Ocular and cervical vestibular evoked myogenic potentials (VEMP) and video head impulse test (vHIT) assess vestibulo-ocular reflex and otolithic function of the sacculus and utricle. The gold standard for diagnosis is caloric testing, which selectively assesses vestibular function on each side in the low-frequency domain (~0,003 Hz) using bithermal (30°C and 44°C) caloric irrigations with water or air. VEMP and vHIT are more comfortable for adolescents and well accepted, while during the caloric test, adolescents often report discomfort, dizziness, and nausea (1).

Conclusion

Peripheral vertigo in childhood and adolescence is often unrecognized, insufficiently evaluated, or misdiagnosed. Diagnosing vertigo in adolescence is challenging due to its association with various diseases and atypical clinical presentations. Otorhinolaryngologists and audiovestibular evaluations play crucial roles in establishing the correct diagnosis. Collaboration between pediatricians and

otorhinolaryngologists is essential for accurate and timely diagnosis and treatment.

Authors' Contributions: Conception and design: MGČ and JK; Acquisition, analysis and interpretation of data: MGČ, ŽLK, DB; Drafting the article: MGČ, JK; Revising it critically for important intellectual content: MGČ, ŽLK, JK and DB; Approved final version of the manuscript: MGČ, ŽLK, JK and DB.

Conflict of Interest: The authors declare that they have no conflict of interest.

References

1. Birtić D, Butigan D, Grebenar Čerkez M, Kovač L, Roje Bedeković M, Sunara D et al. Guidelines for diagnostics and treatment of acute vertigo and imbalance. *Med Jaderina*. 2020;50(3):169-77.
2. Brodsky JR, Lipson S, Bhattacharyya N. Prevalence of pediatric dizziness and imbalance in the United States. *Otolaryngol Head Neck Surg*. 2020;162:241-7. DOI: 10.1177/0194599819887375.
3. Niemensivu R, Pyykko I, Wiener-Vacher SR, Kentala E. Vertigo and balance problems in children - an epidemiologic study in Finland. *Int J Pediatr Otorhinolaryngol*. 2006;70:259-65. DOI: 10.1016/j.ijporl.2005.06.015.
4. Humphriss RL, Hall AJ. Dizziness in 10 year old children: an epidemiological study. *Int J Pediatr Otorhinolaryngol*. 2011;75:395-400. DOI: 10.1016/j.ijporl.2010.12.015.
5. Russell G, Abu-Arafeh I. Paroxysmal vertigo in children - an epidemiological study. *Int J Pediatr Otorhinolaryngol*. 1999;49:105-7. DOI: 10.1016/s0165-5876(99)00143-3.
6. Taylor J, Goodkin HP. Dizziness and vertigo in the adolescent. *Otolaryngol Clin North Am*. 2011;44:309-21. DOI: 10.1016/j.otc.2011.01.004.
7. Gioacchini FM, Alicandri-Ciuffelli M, Kaleci S, Magiulo G, Re M. Prevalence and diagnosis of vestibular disorders in children: a review. *Int J Pediatr Otorhinolaryngol*. 2014;78:718-24. DOI: 10.1016/j.ijporl.2014.02.009.
8. Langhagen T, Albers L, Heinen F, Straube A, Filippopoulos F, Landgraf MN et al. Period prevalence of dizziness and vertigo in adolescents. *PloS One*. 2015;10(9):e0136512. DOI: 10.1371/journal.pone.0136512.
9. Cumberworth VL, Patel NN, Roger W, Kenyon GS. The maturation of balance in children. *J Laryngol Otol*. 2007;121:449-54. DOI: 10.1017/S0022215106004051.
10. Hirabayashi S, Iwasaki Y. Developmental perspective of sensory organization on postural control. *Brain Dev*. 195;17:111-3. DOI: 10.1016/0387-7604(95)00009-z.

11. Filippopoulos FM, Alberts L, Straube A, Gerstl L, Blum B, Langhagen T et al. Vertigo and dizziness in adolescents: risk factors and their population attributable risk. *PloS One*. 2017;12(11):e0187819. DOI: 10.1371/journal.pone.0187819.
12. Castillo-Bustamante M, Barona Cabrera M, Suarez Angulo S, Garcia Campuzano M, Garcia A, Madrigal J. Facts of Vertigo in Adolescents: Controversies and Challenges - A Narrative Review. *Cureus*. 2022;14(8):e28294. DOI: 10.7759/cureus.28294.
13. Smitherman TA, Burch R, Sheikh H, Loder E. The prevalence, impact, and treatment of migraine and severe headaches in United States: a review of statistics from national surveillance studies. *Headache*. 2013;53:427-36. DOI: 10.1111/head.12074.
14. Olsen J, Lipton RB. Migraine classification and diagnosis. International Headache Society criteria. *Neurology*. 1994;44:0-10.
15. Castillo-Bustamante M, del Cid Chua C, Vasquez M, Bello Dotel L, Baez Recalde M. Estrogen and neurootological disorders in women, Sexual hormones and neurootological disorders in women. *Rev Fac Cein Med Univ Nac Cordoba*. 2020;77:351-5. DOI: 10.31053/1853.0605.v77.n4.29349.
16. Nocini R, Baraldi C, Apa E, Ciordoba A, Monzani D, Palma S. Visually evoked postural response (VEPRs) in children with vestibular migraine. *Children*. 2021;9:14. DOI: 10.3390/children9010014.
17. Langhagen T, Landgraf NM, Huppert D, Heinen F, Jahn K. Vestibular Migraine and Children and Adolescents. *Curr Pain Headache Rep*. 2016;20:67. DOI: 10.1007/s11916-016-0600-x.
18. Wang A, Zhou G, Kawai K, O'Brien M, Shearer AE, Brodsky JR. Benign paroxysmal positional vertigo in children and adolescents with concussion. *Sports Health*. 2021;13:380-6. DOI: 10.1177/1941738120970515.
19. Galluzzi F, Garavello W. Benign paroxysmal positional vertigo in children: a narrative review. *J Int Adv Otol*. 2022;18:177-82. DOI: 10.5152/iao.2022.20087.
20. Wang A, Fleischman KM, Kawai K, Corcoran M, Brodski JR. Persistent postural-perceptual dizziness in children and adolescents. *Otol Neurotol*. 2021;42:0. DOI: 10.1097/MAO.0000000000003212.
21. Staab JP. Persistent Postural-perceptual Dizziness. *Semin Neurol*. 2020;40:130-137. DOI: 10.1055/s-0039-3402736.
22. Lukež-Perković I, Vojnić J. Diagnostics of peripheral vertigos with the emphasis on new diagnostic procedures [in Croatian]. *Glasnik pulske bolnice*. 2013;10(10):30-6. Available from: <https://hrcak.srce.hr/130678>.