

Clinical Diagnosis of Central Vertigo in Patients with Dizziness in Emergency Practice

Akiko Umibe, MD ^a, Tadashi Kitahara, MD, PhD ^b, Satoshi Aoki, MD ^a, Yumi Suzuki, MD ^a,
Kosuke Tochigi, MD ^a, Keisuke Miyashita, MD ^a, Kanako Ihara, MD ^a, Yukari Inoue, MD ^a,
Utarō Anazawa, MD ^a, Ryohei Akiyoshi, MD, PhD^a, Yoshikata Nishijima, MD ^a, Kazuhiro
Omura, MD ^c, Yasuhiro Tanaka, MD, PhD ^{a,*}

^a*Department of Otorhinolaryngology, Dokkyo Medical University Saitama Medical Center, 2-1-50, Minami-Koshigaya, Koshigaya, Saitama, 343-8555, Japan*

^b*Department of Otolaryngology, Head and Neck Surgery, Nara Medical University, 840 Shijo-cho, Kashihara-city, Nara 634-8522, Japan*

^c*Department of Otorhinolaryngology, The Jikei University School of Medicine, 3-19-18 Nishi shimbashi, Minato-ku, Tokyo 105-8471, Japan*

***Corresponding Author:**

Yasuhiro Tanaka

Department of Otorhinolaryngology, Dokkyo Medical University Saitama Medical Center
2-1-50, Minami-Koshigaya, Koshigaya, Saitama, 343-8555, Japan

Telephone No.: +81-48-965-1111

Fax No.: +81-48-965-8681

Email address: tanakay@dokkyomed.ac.jp

Acknowledgement: No source of support.

Short Title: Diagnosis of vertigo in emergency practice

Date of Submission: 2020/08/28

Conflict of Interest and Source of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or nonprofit sectors. The authors have no funding, financial relationship, or conflicts of interest relevant to this article to disclose.

Abstract

Objective: Life-threatening diseases should be promptly identified to provide appropriate medical care for emergency outpatients experiencing dizziness. However, dizziness is associated with various medical conditions; thus, a definitive diagnosis is challenging. To accurately diagnose vertigo in an emergency outpatient, we conducted a survey on the need to identify vertigo patients in the current outpatient departments.

Methods: The participants included 509 patients who visited the outpatient department at our hospital from February 2014 to May 2017. Overall, 12 characteristics were retrospectively extracted from the patients' medical records: age, sex, visit method, medical history (diabetes, hypertension, cardiac, or cerebrovascular disease), dizziness history, vertigo characteristics, concomitant symptoms, systolic blood pressure, nystagmus, imaging history, diagnosis, and hospitalization department. Univariate and multivariate analyses were performed to identify factors related to central vertigo.

Results: The diagnosis of central vertigo was confirmed when intracranial lesions were detected via imaging. In multivariate analysis, the presence/absence of a history of headache and cardiovascular disease were significantly correlated with central vertigo ($p = 0.002$ and 0.006 , respectively), with odds ratios of 5.18 and 4.38, respectively.

Conclusions: To avoid missing central dizziness in a patient, diagnostic abilities should be improved by including careful interviews and confirmation of the presence/absence

of accompanying symptoms. Furthermore, collaboration with neurology and neurosurgery departments is important for improving the diagnosis in suspected cases.

Keywords: emergency, dizziness, vertigo, stroke, Frenzel glasses

1. Introduction

To provide appropriate medical care to emergency outpatients experiencing dizziness, life-threatening diseases should be promptly identified.

However, a complex combination of various pathological conditions may cause dizziness, and the diagnostic method may not be uniform because the examination method differs depending on the doctor in charge. Thus, dizziness is challenging to diagnose. In particular, patients with cerebrovascular diseases with the chief complaint of vertigo exhibit an array of symptoms, ranging from dizziness and hearing loss to inner ear vertigo; thus, such diseases are difficult to distinguish.

An imaging test is necessary for a definitive diagnosis, and early detection and treatment of cerebrovascular diseases are crucial.

Head impulse (HI), nystagmus type (N), and test of skew (Ts) (HINTs)¹ are the three factors used to evaluate the exclusion diagnosis of central vertigo that occurs in the context of cerebrovascular disease. To improve diagnostic accuracy, HINTs plus,² which includes the evaluation of hearing by combining finger rubs, acute vertigo discrimination method using timing and trigger,³ and blood biomarkers,⁴ has been proposed as a diagnostic marker for cerebral infarction.

To understand the current state of examinations, particularly those used for patients with vertigo in our emergency outpatient department is critical. Thus, we examined methods

used to confirm diagnosis based on the findings of vertigo treatment in the emergency department.

2. Materials and methods

2.1 Target

A total of 509 patients (189 males and 320 females) who visited the outpatient departments at Dokkyo Medical University Saitama Medical Center (29 departments in total) over a period of 3 years and 3 months from February 2014 to May 2017 with a primary complaint of symptoms associated with vertigo were included. The present study conforms to the guidelines issued in the Declaration of Helsinki. This study was approved by the institutional ethics committee of Dokkyo Medical University Saitama Medical Center. Informed consent was obtained via the opt-out approach.

2.2 Factors assessed

The following characteristics were retrospectively examined from the patients' electronic medical records: (1) age, (2) sex, (3) visit method, (4) past history (diabetes/hypertension/cardiac/cerebrovascular disease), (5) dizziness history, (6) vertigo characteristics, (7) concomitant symptoms (headache/cerebellar ataxia/tinnitus/vomiting), (8) systolic blood pressure, (9) nystagmus (gaze nystagmus and positional/positioning nystagmus diagnosed by the doctor who examined each nystagmus; positional/positioning nystagmus

was assessed using Frenzel glasses), (10) presence/absence of imaging, (11) diagnosis, and (12) hospitalization department.

2.3 Diagnostic method

The diagnosis was determined based on the examination findings and medical records of the patients. Among patients with central vertigo who underwent an imaging examination, those in whom the final diagnosis was a new central lesion were considered relevant cases. A diagnosis of peripheral vestibular vertigo was established according to the diagnostic criteria of the Barany Society and the Japan Society for Equilibrium Research.⁵⁻⁹

2.4 Statistical method

Univariate and multivariate analyses were performed to determine the factors associated with central vertigo among the characteristics (1)–(9) from the aforementioned characteristics in 53 patients with central vertigo and 456 patients with non-central vertigo among the 509 total patients.

2.4.1 Univariate analysis

Mann–Whitney *U* test was used to assess age and systolic blood pressure, and the chi-square test was used for the other assessed factors (Table 1).

2.4.2 Multivariate analysis

For the statistical analysis, SPSS (version 25; IBM SPSS Statistics for Mac, IBM Corporation, Armonk, New York, United States) was used, and a p-value of <0.05 was

considered statistically significant. A logistic regression analysis was performed using clinically relevant covariates that were selected *a priori* as well as covariates for which statistically significant differences between the groups was achieved, denoted as $p < 0.05$ (Table 2).

3. Results

3.1 Age and sex

This study included 189 males (median age: 68 years) and 320 females (median age: 67 years) with a high proportion of women in their 60s and 70s.

Among these subjects, central vertigo was observed in 26 males and 27 females, and there was no significant difference according to age or sex (age: $p = 0.109$; sex: $p = 0.058$).

3.2 Visit method

A total of 385 patients (75.6%) were transported via ambulance and 124 (24.3%) visited unaided. Among them, there was no significant difference in the incidence of central vertigo between 38 emergency transport cases and 14 unaided cases ($p = 0.713$).

3.3 Past history

A total of 75 patients (14.7%) had a history of diabetes, but there was no significant difference in the incidence of central vertigo ($p = 0.47$). Additionally, 167 patients (32.8%) had a history of hypertension, but there was no significant difference in the incidence of

central vertigo ($p = 0.24$). Moreover, 97 patients (19.0%) had a history of cardiovascular disease, and a significant difference was observed in the incidence of central vertigo ($p = 0.047$).

3.4 History of dizziness

Patients with and without history of dizziness were 127 (24.9%) and 74 (14.5%), respectively; however, there was no significant difference between the groups ($p = 0.12$).

3.5 Vertigo characteristics

Patients who complained of rotational vertigo were 179 (35.1%) whereas 123 (24.1%) patients complained of floating dizziness, and there was a significant difference between the groups ($p < 0.05$).

3.6 Concomitant symptoms (headache/cerebellar ataxia/tinnitus/vomiting)

A total of 46 patients (9%) complained of headache, and a significant difference was observed in the incidence of central vertigo ($p = 0.001$). Cerebellar symptoms were observed in nine patients (1.7%), with a significant difference observed ($p < 0.05$). Tinnitus was experienced in 60 patients (11.8%), and no significant difference was observed ($p = 0.16$). Additionally, 247 cases (48.5%) experienced vomiting, but no significant difference was observed in the incidence of central vertigo ($p = 0.77$).

3.7 Systolic blood pressure

The median systolic blood pressure values were 151 mmHg for the non-central vertigo cases

and 165 mmHg for the central vertigo cases; a significant difference was observed in the incidence of central vertigo ($p = 0.001$).

3.8 Presence or absence of nystagmus

A total of 384 patients (75.4%) underwent a gaze nystagmus test and 282 (55.4%) underwent a head position nystagmus test. Among them, 124 patients (24.4%) exhibited gaze nystagmus, with no significant difference observed in the incidence of central vertigo ($p = 0.84$), and 177 (34.8%) exhibited positional/positioning nystagmus, with no significant difference observed ($p = 0.27$).

The positional/positioning nystagmus tests were performed by the otolaryngology department.

3.9 Imaging examination

Computed tomography (CT) was performed for 301 patients (59.1%), whereas magnetic resonance imaging (MRI) was performed for 119 patients (23.4%). Moreover, 93 patients (18.3%) underwent both CT and MRI. Among them, 44 cases (8.6%) of central vertigo were diagnosed via CT, 36 (7.1%) via MRI, and 27 (5.3%) via both imaging modalities. In six cases, central lesions (infarcts) without abnormalities were identified on CT scans.

3.10 Diagnosis

A total of 336 cases (65.8%) of peripheral vertigo (unclear diagnosis), 71 (13.9%) of benign

paroxysmal positional vertigo, 33 (6.5%) of Meniere's disease, 9 (1.8%) of vestibular neuritis, 5 (0.98%) of sudden deafness, and 1 (0.2%) of anemia were diagnosed. Furthermore, one pregnant woman and three patients with malignant diseases, including lung cancer and malignant lymphoma, exhibited peripheral dizziness. Additionally, 53 patients (10.0%) were diagnosed with central vertigo, including 39 with cerebral infarction, 13 with cerebral hemorrhage, and one with subarachnoid hemorrhage.

3.11 Inpatient department

A total of 156 patients were hospitalized. Essentially, the department in charge of the first visit determines whether hospitalization is necessary. It was noted that 93 patients (18.3%) were admitted to the otolaryngology department, 52 (10.2%) to the neurosurgery department, and the remainder to the neurology, diabetics, cardiovascular, gynecology, and respiratory medicine departments.

Of the 53 patients with central vertigo, 43 were admitted to neurosurgery and 10 were hospitalized in the neurology department. A total of six patients were transferred to the otolaryngology department at the first visit but were admitted to neurosurgery after being diagnosed with central vertigo.

3.12 Multivariate analysis

A multivariate analysis was performed including characteristics (1)–(9) using a logistic regression analysis. A significant correlation of the history of headache and history of

cardiovascular disease with central vertigo was determined, with odds ratios of 5.18 and 4.38 ($p = 0.002$ and $p = 0.006$), respectively.

4. Discussion

4.1 Comparisons with other facility data

According to the Ministry of Health, Labour and Welfare, the incidence of dizziness is 13.2 and 30.2 per 1,000 individuals among men and women, respectively, in Japan.¹⁰

According to the literature, patients with dizziness are considerably older, and dizziness is more common among women.¹¹ Globally, the prevalence of dizziness ranges from 1.8% in young adults to more than 30% in older adults,¹² and it accounts for approximately 4.4% of major symptoms observed in the emergency department.¹³

Emergency vertigo symptoms are most often diagnosed in otologic/vestibular diseases and in disorders of cardiovascular, respiratory, cranial, metabolic, psychiatric, digestive, and genitourinary systems as well as in cases of injury and addiction. Vertigo was reported in 49.2% of medical diagnoses¹¹ and 22% of 907 patients presenting to the emergency department with dizziness were not diagnosed in prospective studies where neurologists intervened in the diagnosis.¹⁴ The diagnosis was not confirmed in many cases in this study; therefore, it is necessary to improve the diagnostic rate.

The previously reported prevalence of central dizziness varies between 3% and 16.8% depending on the facility^{11,15-17}; similar results were obtained in this study. Risk factors for central vertigo include headache and cardiovascular disease, which is in accordance with this study data; additionally, age >55 years; male sex; and a history of hypertension, diabetes, and dyslipidemia have been reported as risk factors.^{18,19} In particular, high blood pressure,²⁰ heart disease,^{20,21} diabetes,²⁰ and headache²¹ are risk factors for stroke. These risk factors can be diagnosed at any facility at any time; thus, they should be assessed through interviews.

In this study, six (1.2%) patients who were transferred to the otolaryngology department at the first visit had central vertigo. In addition to experiencing dizziness, many of these patients exhibited accompanying symptoms of central vertigo, such as restlessness, difficulty in standing up, and dysarthria. A careful examination of such accompanying symptoms is necessary.

4.2 Importance of identifying stroke

Patients visiting due to primary complaint of central vertigo generally have cerebellar and brainstem lesions and approximately 20% of these cerebral ischemic lesions have been reported to occur in the vertebrobasilar system.²² Another report has stated that 25% of patients with cerebral infarction in the posterior circulation have isolated vertigo syndrome.²³ In patients with anterior inferior cerebellar artery (AICA) infarction, hearing loss, dizziness, and tinnitus may occur as initial symptoms 1–10 days prior to infarction. In patients with

posterior inferior cerebellar artery infarction, cases of fixed-direction gaze nystagmus, similar to gaze nystagmus of inner ear dizziness, have been observed.²² Thus, it is difficult to distinguish between isolated vertigo and peripheral vertigo. A misdiagnosis rate of 35% for stroke in the posterior circulation in patients with vertigo has been reported in one study.²⁴

Causes of misdiagnosis include insufficient evaluation at the time of examination and problems with the testing equipment.

According to a report by Savitz et al., insufficient evaluation at the time of diagnosis occurs due to assumptions based on age and history and due to inadequate evaluation of eye movements, cooperative movements, and walking examinations.²⁵ In this study, of the total number of patients with central vertigo, one was in her 30s and seven were in their 40s; thus, approximately 15% of the patients were younger than 50 years.

In addition, two limitations of the imaging equipment are as follows: the facility of and judgment ability regarding imaging examination (CT/MRI) and the lack of Frenzel glasses.

A definitive diagnosis of stroke requires imaging, but CT and MRI may not be available at night in all facilities. In particular, MRI examinations are time consuming and expensive and are contraindicated in some patients with metal in their bodies.

Furthermore, CT has a sensitivity of 16% for acute ischemic stroke, whereas MRI has a sensitivity of 83%²⁶; therefore, despite obtaining CT and MRI in cases of acute ischemic

stroke, the diagnosis may demonstrate no abnormality. At our hospital, MRI can be performed at night. In this study, of the 93 patients for whom both CT and MRI were performed, CT findings were normal, whereas infarction was identified on MRI in six patients. Thus, performing both imaging examinations helps prevent misdiagnosis. Additionally, three of the six patients had a history of headache or cardiovascular disease, both of which correlated with central vertigo in the multivariate analysis in this study. If possible, CT and MRI should be performed for patients with dizziness, even if they exhibit only one symptom.

Furthermore, in this study, only the otolaryngology department performed positional/positioning nystagmus examinations using Frenzel glasses. Frenzel eyeglasses are an important device for distinguishing dizziness. In Japan, the method of using Frenzel glasses is described in textbooks studied in medical schools; however, the usage frequency of these glasses differs among different clinical departments when used in practical training. This is likely the reason why they are not used in clinical departments other than otolaryngology departments. However, some hospitals provide assistance to emergency departments during nystagmus examinations using Frenzel glasses.¹⁵ If cervical symptoms are noted during head rotation, this relatively minimally invasive examination can also be used in other departments. Therefore, providing proper instructions on the use of Frenzel glasses can help improve the diagnostic rate.

4.3 Limitations

To overcome the limitations of these imaging devices, several studies have explored methods for differentiating central vertigo without imaging examination. HINTs is a useful test with a higher sensitivity and specificity than imaging examinations¹; HINTs plus has been proposed to detect the hearing loss that occurs in patients with AICA infarctions.² Furthermore, one study has shown that hospitalization and imaging test rates are lower in patients in whom spontaneous nystagmus, direction, head impulse, and standing are examined in advance than in the control group.²⁷

The present results show that the most important way to avoid missing a stroke is an accurate examination and comprehensive patient consultation while paying attention to the accompanying symptoms of dizziness. Furthermore, it is difficult to reach a definitive diagnosis with only one examination; thus, oversight can be prevented by performing a combination of imaging examinations, Frenzel glasses, HINTs, etc.

Second, in this study, there were six patients in whom a stroke was first identified in the otolaryngology department, following which they were hospitalized in the neurosurgery/neuropathology department. Thus, cooperation among departments is important to prevent oversight. For example, if a patient is diagnosed with dizziness and is suspected of having central vertigo, he or she is referred to an appropriate department (neurosurgery/neuropathology). Because patients with the chief complaint of vertigo visit

various departments, it is important to collaborate not only with otolaryngology and neurosurgery/neuropathology departments but also with internal medicine and general surgery departments.

This was a retrospective study, and some of the 12 factors may not have been completely reported by the patients. Factors necessary for diagnosing dizziness must be reconsidered based on the results of this study.

5. Conclusions

We examined 509 patients who visited the emergency department with the chief complaint of dizziness. The disease diagnoses were distributed as follows: peripheral vertigo (unclear diagnosis), 65.8%; benign paroxysmal positional vertigo, 13.9%; Meniere's disease, 6.5%; vestibular neuritis, 1.8%; sudden hearing loss, 0.98%; and anemia, 0.2%. A total of 10.0% of patients were diagnosed with central vertigo, which included 42 patients with cerebral infarction, 10 with cerebral hemorrhage, and one with subarachnoid hemorrhage; six of these patients were transferred to the otolaryngology department at the first visit. Those with a diagnosis of vertigo were admitted to the Department of Neurosurgery.

The statistical analysis revealed that patients with a history of headache symptoms and cardiovascular disease were significantly more likely to experience central vertigo.

To avoid misdiagnosing central vertigo, it is important to improve general medical examinations, such as interviews and neurological examinations. Furthermore, multiple examinations such as imaging and positional/positioning nystagmus testing using Frenzel glasses should be performed, and physicians should cooperate with other departments.

Data Availability Statement

The datasets used or analyzed in the current study are available from the corresponding author on reasonable request.

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