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Case study

Final diagnosis of patients with clinically suspected vestibular neuritis showing normal caloric response

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ABSTRACT

Vestibular neuritis is one of the most common peripheral causes of acute vestibular syndrome, of which the diagnosis is generally based on a comprehensive interpretation of clinical and laboratory findings following reasonable exclusion of other disorders. This study aimed to investigate the final diagnosis of patients admitted to hospital under the clinical impression of vestibular neuritis who showed no unilateral caloric paresis.

Forty-five patients who visited the emergency department with isolated acute spontaneous vertigo were included. Among them, six patients (13%) developed definitive spontaneous vertigo lasting longer than 20 min again after discharge from hospital, accompanied by hearing loss, which was audiometrically documented, leading to a final diagnosis of definite Ménière's disease. Nine patients (20%) revisited our clinic with recurrent episodic vertigo without any documented hearing loss or auditory symptoms such as hearing loss, tinnitus or ear fullness, which led to a final diagnosis of possible Ménière's disease. In four patients (9%), initial spontaneous vertigo and nystagmus changed to positional vertigo and nystagmus on the second hospital day. In 26 patients (58%), neither another episode of vertigo nor auditory symptoms developed during follow-up period (7–92 months), a condition to which the authors gave an arbitrary diagnosis of "mild unilateral vestibular deficit". In conclusion, patients admitted to hospital under clinical impression of vestibular neuritis may have various final diagnoses, and "mild unilateral vestibular deficit" was the most common final diagnosis among patients who did not meet the diagnostic criteria of vestibular neuritis.

1. Introduction

Vertigo accounts for approximately 1% of the symptoms in an average emergency department [1]. Acute vestibular syndrome is a clinical condition caused by acute, unilateral vestibular deficit of either peripheral or central origin, and characterized by severe vertigo [2]. It is important in the emergency department to differentiate peripheral lesions such as those accompanying vestibular neuritis from central disorders such as infarction or hemorrhage in the brainstem or cerebellum, and neurotological examinations and/or imaging studies are essential for such a differential diagnosis [3].

Vestibular neuritis is one of the most common peripheral causes of acute vestibular syndrome, and has key signs and symptoms including acute onset of spinning vertigo, nausea/vomiting, postural unsteadiness, spontaneous horizontal-torsional nystagmus beating towards the unaffected side, pathological head impulse test, and no evidence for central vestibular or ocular motor dysfunction [4,5]. In addition, unilateral caloric hyporesponsiveness (canal paresis ≥25%) in caloric testing has been the diagnostic hallmark of vestibular neuritis, even though caloric testing can evaluate only the function of the horizontal semicircular canal in the lower frequency range (~0.003 Hz) [5]. The ability to conduct more accurate diagnosis of vestibular neuritis in the emergency department would help in determining the need for admission [1] and in rationalizing early, systemic administration of corticosteroids, for which there is evidence of benefit in patients with vestibular neuritis [6]. However, since no single, pathognomonic clinical sign or laboratory test has been introduced to diagnose vestibular neuritis, this diagnosis is generally based on a comprehensive interpretation of clinical features and laboratory findings allowing reasonable exclusion of other disorders. Furthermore, neurotologists in emergency departments mostly make a preliminary diagnosis of vestibular neuritis from clinical symp-

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toms and signs because laboratory tests such as caloric testing cannot be performed until acute symptoms are relieved so that patients can endure the testing. If the diagnosis is made based only on clinical signs and symptoms, some conditions, such as the first monosymptomatic vertigo attack with a prolonged duration in Ménière's disease, can be confused with vestibular neuritis.

We aimed to investigate the final diagnosis of patients who were diagnosed with vestibular neuritis based on clinical signs and symptoms in the emergency department and who showed no unilateral caloric paresis on caloric testing, which was performed later during admission.

2. Subjects and methods

2.1. Subjects

We retrospectively evaluated 45 patients with isolated acute spontaneous vertigo (17 men and 28 women; 55 ± 12 years) who were clinically diagnosed with vestibular neuritis at our emergency department but showed normal caloric canal paresis (CP) values between February 2006 and August 2014. Clinical diagnosis of vestibular neuritis was made when; (1) the patients complained of sudden onset of spontaneous vertigo without any reported auditory symptoms such as hearing loss, tinnitus, or ear fullness on either side, (2) direction-fixed unidirectional horizontal-torsional spontaneous nystagmus was observed using Frenzel glasses or goggles with infrared camera, (3) horizontal head impulse test revealed corrective saccades on the side of slow-phase spontaneous nystagmus, (4) positional nystagmus was not observed, and (5) the patients who met the diagnostic criteria for migrainous vertigo [7] which was based on the history of migrainous symptoms temporally related to recurrent vertigo, were excluded. During the same period, 225 patients were finally diagnosed with unilateral vestibular neuritis among patients who were clinically diagnosed with vestibular neuritis at emergency department.

The Rinne test was positive, and the Weber test showed no lateralization. Patients with interaural differences of more than 15 dB in pure tone threshold were excluded from the study. Neurologic examination revealed no other focal neurologic sign. No patient complained of otalgia, and none showed eruptive vesicles in the ear or facial paralysis. Patients with previous history of hearing loss, vertigo, migraine, or other neurotologic diseases were excluded from the study. History-taking and neurotological examination were performed by the consulted otolaryngologists. In these patients, the time between the onset of vertigo and the decision of admission after examinations by otolaryngologists was at least six hours, during which spinning vertigo and nausea/vomiting persisted. Brain magnetic resonance imaging (MRI) including diffusion-weighted imaging, did not reveal acute infarction or other acute/chronic brain lesions, including cerebellopontine angle tumors, in any of the patients. Under the clinical impression of unilateral vestibular neuritis, the patients were admitted to the hospital's department of otorhinolaryngology.

2.2. Vestibular function tests

A bithermal caloric test was performed, while recording eye movements, using an infrared video-based system (CHARTR VNG, ICS Medical, Schaumburg, IL, USA). Each ear was irrigated with a constant flow of water at alternating temperatures of 30 °C and 44 °C for a constant period of time (30 s). The maximum SPV of nystagmus was calculated following each irrigation, and Jongkees' formula was used to determine CP. A CP ≥25% was considered abnormal. A bithermal caloric test was performed within seven days after the onset of vertigo, which revealed no canal paresis (<25%) in any patient.

Cervical vestibular-evoked myogenic potential (cVEMP) test were performed with an auditory evoked potential system (Navigator Pro®, Bio-logic Systems Corp., IL, USA). Active electrodes were placed on the upper one-third of the contracted SCM muscle, and the reference electrode was placed on the upper part of the sternum below the attachment of the SCM muscles. Ground electrode was attached on the forehead. Skin impedance was less than 5 kΩ. The responses were obtained from each side separately using 500 Hz tone bursts (rise/fall time = 1 ms, plateau time = 2 ms, repetition rate = 5 Hz) which were delivered unilaterally with an insert earphone. The acoustically evoked cVEMP responses were amplified, band-pass filtered (30 Hz–1.5 kHz) and averaged. Each side was subject to runs of 128 tone bursts, and the results were averaged. cVEMP responses were recorded for each subject at different sound intensities of 95, 90, 85, 80, 75, 70, 65 and 60 dB nHL. An absent reflex was defined when there was no recognizable tracing, while the stimulation intensities were decreasing from 95 dB nHL. The interaural amplitude difference ratio (IADR) was calculated, which was considered abnormal when IADR value was greater than 45% [8].

During hospitalization, auditory symptoms such as hearing loss, tinnitus, or ear fullness did not newly develop, and pure tone audiometry showed no hearing loss in either ear. The patients were discharged from the hospital after management of acute symptoms, and followed up one week after discharge. All patients were instructed to return if vertigo redeveloped. The patients' charts were retrospectively reviewed, and they were contacted by telephone by an experienced otolaryngologist to incite them for provide further information. Mean follow-up period was 32 ± 27 months. The Institutional Review Board approved the study (KUH1110027).

3. Results

Of these 45 patients, who showed clinical features of vestibular neuritis in the emergency department but no canal paresis in a caloric test, six (13%) were ultimately diagnosed with definite Ménière's disease (Fig. 1). Definitive spontaneous vertigo lasting longer than 20 min redeveloped in these patients, and hearing loss was audiometrically documented, with other auditory symptoms such as tinnitus and ear fullness at the time of vertigo re-attack,

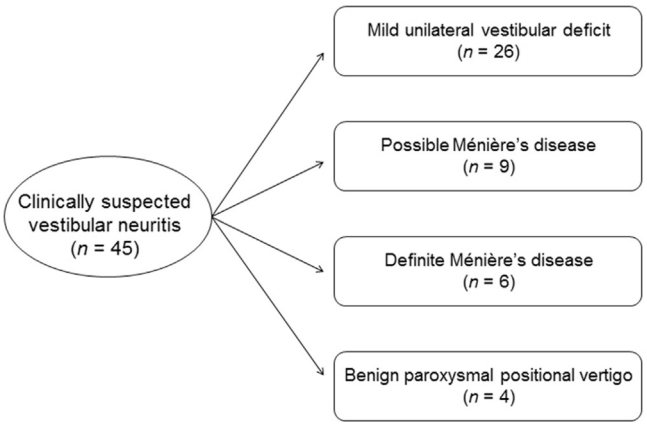

Fig. 1. Final diagnosis of patients who were clinically suspected of vestibular neuritis in the emergency department but later showed normal caloric response ($n = 45$). The most common final diagnosis was "mild unilateral vestibular deficit" ($n = 26$), followed by possible Ménière's disease ($n = 9$), definite Ménière's disease ($n = 6$), and benign paroxysmal positional vertigo ($n = 4$).

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leading to a final diagnosis of definite Ménière's disease [9]. Nine patients (20%) revisited our clinic with recurrent episodic vertigo without any documented hearing loss, which led to a final diagnosis of possible Ménière's disease [9]. In these 15 patients with final diagnosis of (definite or possible) Ménière's disease, the duration of nystagmus was less than 24 h, even though nonspecific dizziness lasted longer.

Four patients (9%) developed positional vertigo during the period of hospitalization. One patient, who had shown left-beating spontaneous nystagmus without positional nystagmus in the emergency department, showed downbeating-torsional nystagmus with the upper pole of the eye beating toward the right side according to both Dix–Hallpike tests on the second hospital day, which led to a final diagnosis of anterior semicircular canal (ASCC) benign paroxysmal positional vertigo (BPPV) on the right side. In three patients, persistent geotropic direction-changing positional nystagmus (DCPN) with stronger intensity on the side of slow-phase spontaneous nystagmus at the initial examination was elicited by a supine-roll test on the second hospital day. Geotropic DCPN was converted to apogeotropic DCPN in two of these three patients (Fig. 1).

In 26 patients (of 45, 58%), neither another episode of vertigo nor auditory symptoms such as hearing loss, tinnitus, or ear fullness developed during the follow-up period (31 ± 26 months; range, 7–92 months), which was the most commonly observed type (Fig. 1). During hospitalization, spontaneous nystagmus lasted for longer than one day. The authors gave an arbitrary diagnosis of "mild unilateral vestibular deficit" because an appropriate diagnosis could not be made, even though these patients mimicked clinical features of those with vestibular neuritis, with the exception of the caloric responses.

Of these 45 patients, abnormal cVEMP response was observed in 6 patients. Final diagnoses of these 6 patients were possible Ménière's disease in 3, definite Ménière's disease in 2, and BPPV in 1 patient. The patient with BPPV showed persistent geotropic DCPN on the second hospital day, and the intensity of nystagmus was gradually decreased without change in direction of positional nystagmus. All of 45 patients denied medical history of migrainous symptoms during the follow-up period.

4. Discussion

The term "vestibular neuronitis" was first used in 1952, for the purpose of distinguishing this condition from Ménière's disease [10]. However, because there is no confirmatory diagnostic test for vestibular neuritis, a diagnosis of vestibular neuritis is a diagnosis of exclusion. Generally, the diagnostic criteria for vestibular neuritis include sudden onset of vertigo persisting for more than one day, with unidirectional horizontal-torsional spontaneous nystagmus, absence of other auditory and neurologic findings, reduced caloric responses (canal paresis $\geq$25% in our laboratory), and no previous history of vertigo or other neurotologic diseases [11,12].

In emergency departments, consulted otolaryngologists primarily determine the admission of patients under the clinical impression of vestibular neuritis by means of clinical findings, without laboratory tests such as caloric testing. In addition to symptomatic treatment with antivertiginous drugs, improved recovery of peripheral vestibular function at one month can be expected by administering systemic corticosteroid [6], which, however, does not have enough evidence for effectiveness in treatment of patients with acute cerebral infarction or Ménière's disease [13]. Furthermore, systemic corticosteroids may cause inadvertent side effects in the skin and eye and in the musculoskeletal, metabolic and endocrine, cardiovascular, gastrointestinal, immune, and central nervous systems [14].

In the present study, we investigated the final diagnosis of patients who were admitted to the department of otolaryngology under the clinical impression of vestibular neuritis but who showed no canal paresis in a caloric test. Six patients (of 45; 13%) were later diagnosed with definite Ménière's disease, and it is thought that isolated vertigo had developed in these patients as a symptom of early-stage Ménière's disease. These patients had severe spinning vertigo and vomiting lasting more than six hours, and some of them complained of nonspecific dizziness for more than one day. It is known that an attack of vestibular neuritis usually starts with cochlear symptoms followed by vertigo, which generally lasts at least 20 min and not more than 24 h [15], although nonspecific dizziness may persist longer than 24 h. However, in the previous study, vertigo was the only initial symptom in approximately 25% of the patients with Ménière's disease [16]. Nine patients who had recurrent episodes of isolated vertigo without documented hearing loss or other cochlear symptoms were finally diagnosed with possible Ménière's disease [9].

The feature of vertigo was changed to positional vertigo on the second hospital day in four patients (of 45, 9%), of which ASCC BPPV was observed in one patient and persistent geotropic DCPN in three patients. The patient with ASCC BPPV was treated after two sessions of canalith repositioning maneuver; damage of the utricle, which resulted in otoconial dislodgement, might have been responsible for the development of this condition [17]. It has been reported that persistent geotropic DCPN on supine roll test can be observed in some patients with positional vertigo without any accompanying inner ear or neurologic symptoms [18–20]. Although its pathophysiologic mechanism is still unclear, a concept of the light cupula has been introduced to explain the occurrence of persistent geotropic DCPN, which indicates the cupula with lower specific gravity than the surrounding endolymph of which specific gravity is same as that of the cupula under normal condition. The patients with sudden sensorineural hearing loss [21,22], serous labyrinthitis [23], or human immunodeficiency virus encephalopathy [24] may also show persistent geotropic DCPN. In two of three patients with persistent geotropic DCPN, the direction of nystagmus was later changed to apogeotropic DCPN; this conversion of nystagmus direction was reported in a previous studies [25,26]. Although the mechanism for the conversion from geotropic to apogeotropic DCPN still remains unclear, the condition of light cupula might have been changed to heavy cupula in the lateral semicircular canal. Given that this study demonstrated that some patients admitted under the clinical impression of vestibular neuritis may exhibit positional nystagmus and vertigo during hospitalization, serial examination of spontaneous and positional nystagmus would be helpful for the proper evaluation of such patients.

Twenty-six patients (of 45; 58%) showed clinical features that were the most similar to those of vestibular neuritis, except for the caloric response. This might be explained by early recovery of vestibular impairment, mild vestibular deficit, or inadequate follow-up period (31 ± 26 months; range, 7–92 months), after which vestibular attacks or auditory symptoms may recur. Currently, a diagnosis for this condition does not exist, and so we arbitrarily named it "mild unilateral vestibular deficit", a label that, we think, needs further discussion by researchers in this field.

While vestibular neuritis classically refers to a condition of a viral inflammation limited to the superior vestibular nerve and usually has an associated canal paresis on caloric test, it is currently understood to be an inflammation of all or parts of the superior, inferior, or both vestibular nerves giving rise to different manifestations of disease. It was reported that while patients with vestibular neuritis showed a high proportion of ocular VEMP (oVEMP) abnormalities, most of them showed normal cVEMP responses [27], which indicates that the superior vestibular nerve

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is more commonly impaired than the inferior vestibular nerve in patients with vestibular neuritis. In the present study, only 6 patients (of 45, 13%) showed abnormal cVEMP responses, which may suggest that both the superior vestibular nerve, considering the presence of direction-fixed unidirectional horizontal-torsional spontaneous nystagmus and horizontal head impulse test was positive on the side of slow-phase spontaneous nystagmus, and inferior vestibular nerve were involved in these patients.

5. Conclusion

Patients admitted to hospital under the clinical impression of vestibular neuritis may have various final diagnoses. Definite Ménière's disease, possible Ménière's disease, and BPPV were diagnosed in 6 (13%), 9 (20%), and 4 (9%) patients, respectively. Twenty-six patients (of 45; 58%) showed clinical features that were the most similar to those of vestibular neuritis, only except for the caloric response, and we arbitrarily named it "mild unilateral vestibular deficit", which may need further discussion. Thus, close follow-up during and after hospitalization is important for the proper evaluation of the patients who were admitted to the hospital under the clinical impression of vestibular neuritis.

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Conflict of interest

No conflict of interest for any author.

References

[1] Newman-Toker DE, Hsieh YH, Camargo Jr CA, et al. Spectrum of dizziness visits to US emergency departments: cross-sectional analysis from a nationally representative sample. Mayo Clin Proc 2008;83(7):765–75.
[2] Hotson JR, Baloh RW. Acute vestibular syndrome. N Engl J Med 1998;339 (10):680–5.
[3] Kattah JC, Talkad AV, Wang DZ, et al. HINTS to diagnose stroke in the acute vestibular syndrome: three-step bedside oculomotor examination more sensitive than early MRI diffusion-weighted imaging. Stroke 2009;40 (11):3504–10.
[4] Strupp M, Magnusson M. Acute Unilateral Vestibulopathy. Neurol Clin 2015;33 (3):669–85.
[5] Jeong SH, Kim HJ, Kim JS. Vestibular neuritis. Semin Neurol 2013;33 (3):185–94.
[6] Fishman JM, Burgess C, Waddell A. Corticosteroids for the treatment of idiopathic acute vestibular dysfunction (vestibular neuritis). Cochrane Database Syst Rev 2011;5:CD008607.
[7] Neuhauser H, Lempert T. Vertigo and dizziness related to migraine: a diagnostic challenge. Cephalalgia 2004;24(2):83–91.
[8] Shin JE, Kim CH, Park HJ. Influence of thresholds on amplitudes in vestibular evoked myogenic potentials. Auris Nasus Larynx 2013;40(4):352–5.
[9] Committee on Hearing and Equilibrium guidelines for the diagnosis and evaluation of therapy in Meniere's disease. American Academy of Otolaryngology-Head and Neck Foundation, Inc.. Otolaryngol Head Neck Surg 1995;113(3):181–5.
[10] Dix MR, Hallpike CS. The pathology, symptomatology and diagnosis of certain common disorders of the vestibular system. Ann Otol Rhinol Laryngol 1952;61 (4):987–1016.
[11] Cooper CW. Vestibular neuronitis: a review of a common cause of vertigo in general practice. Br J Gen Pract 1993;43(369):164–7.
[12] Coats AC. Vestibular neuronitis. Trans Am Acad Ophthalmol Otolaryngol 1969;73(3):395–408.
[13] Sandercock PA, Soane T. Corticosteroids for acute ischaemic stroke. Cochrane Database Syst Rev 2011;9:CD000064.
[14] Schacke H, Docke WD, Asadullah K. Mechanisms involved in the side effects of glucocorticoids. Pharmacol Ther 2002;96(1):23–43.
[15] Harcourt J, Barraclough K, Bronstein AM. Meniere's disease. BMJ 2014;349: g6544.
[16] Kentala E. Characteristics of six otologic diseases involving vertigo. Am J Otol 1996;17(6):883–92.
[17] Karlberg M, Hall K, Quickert N, et al. What inner ear diseases cause benign paroxysmal positional vertigo? Acta Otolaryngol 2000;120(3):380–5.
[18] Kim CH, Kim MB, Ban JH. Persistent geotropic direction-changing positional nystagmus with a null plane: the light cupula. Laryngoscope 2014;124(1): E15–9.
[19] Kim CH, Shin JE, Kim YW. A new method for evaluating lateral semicircular canal cupulopathy. Laryngoscope 2015;125(8):1921–5.
[20] Kim CH, Kim YG, Shin JE, et al. Lateralization of horizontal semicircular canal canalolithiasis and cupulopathy using bow and lean test and head-roll test. Eur Arch Otorhinolaryngol 2016;273(10):3003–9.
[21] Kim CH, Choi JM, Jung HV, et al. Sudden sensorineural hearing loss with simultaneous positional vertigo showing persistent geotropic direction-changing positional nystagmus. Otol Neurotol 2014;35(9):1626–32.
[22] Kim CH, Shin JE, Yang YS, et al. Sudden sensorineural hearing loss with positional vertigo: Initial findings of positional nystagmus and hearing outcomes. Int J Audiol 2016;55(10):541–6.
[23] Kim CH, Yang YS, Im D, et al. Nystagmus in patients with unilateral acute otitis media complicated by serous labyrinthitis. Acta Otolaryngol 2016;136 (6):559–63.
[24] Yang TH, Oh SY. Geotropic central paroxysmal positional nystagmus in a patient with human immunodeficiency virus encephalopathy. J Neuroophthalmol 2014;34(2):159–61.
[25] Shin JE, Jeong KH, Ahn SH, et al. Conversion between geotropic and apogeotropic persistent direction-changing positional nystagmus. Acta Otolaryngol 2015;135(12):1238–44.
[26] Kim YW, Shin JE, Lee YS, et al. Persistent positional vertigo in a patient with sudden sensorineural hearing loss: a case report. J Audiol Otol 2015;19 (2):104–7.
[27] Oh SY, Kim JS, Yang TH, et al. Cervical and ocular vestibular-evoked myogenic potentials in vestibular neuritis: comparison between air- and bone-conducted stimulation. J Neurol 2013;260(8):2102–9.

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