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3D analysis of spontaneous nystagmus in early stage of vestibular neuritis

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Abstract

Objective: The pathological localization of vestibular neuritis is still controversial. Analyses of the spontaneous nystagmus support the temporal bone studies, which indicated the location of the pathology to be in the superior vestibular nerve. However, based on the data from the head impulse testing the pathology is in the vestibular nerve including the inferior branch.
Methods: Twenty-three patients with vestibular neuritis participated in this study. The spontaneous nystagmus was recorded within 1 week after the onset of the disease. Three-dimensional analysis of the nystagmus was performed using video image analysis system. The rotation axis was calculated and compared to the anatomical axes of the semicircular canals.
Results: The axes of the spontaneous nystagmus in all patients were scattered around the axes of horizontal and anterior canals, especially between the compound axis of anterior and horizontal canals and the axis of horizontal canal. The statistical analysis revealed that in the quite early stage of the disease (day 0–2 of the attack), the spontaneous nystagmus tended to have more torsional eye movements as compared to the less early stage (day 3–6).
Conclusion: The present study strongly suggests that the pathology of vestibular neuritis is in the superior vestibular nerve branch. Also it can be speculated that at the early stage of this disease, the pathology is in the whole branch of the nerve. Subsequently, the anterior canal branch recovers faster than the horizontal canal branch.

Keywords: VOG; Eye movement; Slow phase; Velocity vector; Rotation axis; Vestibular compensation

1. Introduction

Vestibular neuritis is characterized by the sudden onset of severe rotatory vertigo without cochlear symptoms. The patients show a loss or heavily diminished caloric response of the affected ear and a spontaneous nystagmus directed towards the healthy side. There are no abnormal signs or symptoms of other central or peripheral nerves. The patients have no previous history of vertigo. The intensive symptoms gradually lessen in a week and most patients can return to work after 1 month.

Regarding the pathological localization of this disease, the superior vestibular nerve is the most likely candidate of this disease. This is supported by the temporal bone study [1] and also by the analysis of spontaneous nystagmus [2,3]. However, Aw et al. [4] stated that there were three groups of pathological lesion, which involved superior and inferior vestibular nerves, superior vestibular nerve and, and lateral canal nerve only, using the head impulse testing. One of the reasons of these different results from study to study, may depend on the different manner of testing or observing from the onset of the disease, since the peripheral vestibular lesion is quickly modified by the central compensation. Fetter and Dichgans [2] recorded spontaneous nystagmus during 2–15 days after the onset of the disease, whereas Aw et al. [4] performed head impulse testing 2–16 weeks after the onset of the disease. It seems quite important to study the eye movements at the very early stage of the disease, since the vestibular compensation occurs quite early stage after the acute unilateral labyrinthine loss [5,6]. Thus, in this study, we record the spontaneous nystagmus within 1 week after the onset of disease to avoid the central compensation as possible as we can.

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Through animal experiments, it is well known that stimulation of the individual semicircular canal nerves causes eye movements in a plane parallel to the plane of the canal [7]. The anatomical axes of individual semicircular canals in humans have been reported by temporal bone studies [8,9]. If the pathology of a peripheral vestibular lesion localizes in a particular semicircular canal or nerve branch, the velocity vector of the slow phase of spontaneous nystagmus in this patient should align with the axis of the particular semicircular canal [10]. The aim of this study was to clarify the pathological localization of the vestibular neuritis without or less influence of the central contribution, non-invasively. In order to do so, we performed a three-dimensional analysis of the spontaneous nystagmus in patients with vestibular neuritis using the video image analysis system developed by Yagi et al. [11].

2. Materials and methods

Twenty-three patients (11 females and 12 males; age range 22–77 years; mean age 49.9 ± 16.2 years) with vestibular neuritis participated in this study. All patients gave their informed consent to participate in this study according to the Declaration of Helsinki. As the clinician knows, the patients with vestibular neuritis have severe vertigo and usually with nausea and vomiting in the early stage of the disease. So that, some times it is quite difficult to take collaboration to the examination by patients. From this situation, it is quite important to use less invasive method to evaluate the patients' vestibular function.

All patients satisfied the criteria for the diagnosis of vestibular neuritis, with a sudden rotatory vertigo lasting several days. None of the patients had cochlear signs, which are hearing loss, tinnitus, and ear fullness. The spontaneous nystagmus always directed towards the healthy side. The caloric test was performed according to the recommendation of the Japanese Standardization Committee 1987 [12] at the same day when the spontaneous nystagmus was recorded. The irrigation of 20 °C, 5 ml water into the external auditory canal with 20 s was performed. The criterion of the grading of the test result is divided into five groups according to the maximum slow phase velocity of the caloric nystagmus, which are normal; more than 20 °/s, probable CP; 10–20 °/s, moderate CP; less than 10 °/s, and severe CP; no response. All the patients exhibited spontaneous nystagmus when the caloric test was performed. The caloric reaction in these conditions was calculated as the algebraic summation of the average slow phase velocity (SPV) of the spontaneous nystagmus and the maximum SPV of the caloric nystagmus. For example, if the average SPV of spontaneous nystagmus is 6 °/s directed towards the left, and the caloric nystagmus stimulating the right and left ears are 6 °/s and 12 °/s, the caloric reaction in the right and left ears are 0 °/s, directed towards the left, and 18 °/s, directed towards the right, respectively. All patients showed moderate (11 patients) or severe CPs (12 patients) as indicated in Table 1. Among 12 patients who showed severe CP, 9 patients received 50 ml

Table 1
Summary of patient data.

Subjects	Age in years	Sex	Side of lesion	Recording day	Caloric test, °/s	
					Diseased side	Healthy side
1	36	M	L	0	0	38
2	56	M	R	1	0	12
3	68	F	R	1	4	18
4	43	M	L	1	9	19
5	55	F	R	1	0	16
6	59	F	R	2	0	13
7	33	F	R	2	2	34
8	22	F	L	2	0	76
9	60	M	R	2	6	72
10	74	M	R	2	0	49
11	61	F	L	2	8	20
12	22	M	R	2	3	12
13	57	M	R	2	4	12
14	63	M	R	3	0	10
15	37	F	L	3	0	22
16	35	M	L	3	0	34
17	67	M	L	3	0	18
18	35	F	L	4	3	10
19	64	F	R	5	0	24
20	43	M	R	5	0	18
21	77	F	L	5	2	15
22	53	F	L	6	0	27
23	28	M	R	6	2	28

M; male, F; female, L; left, R; right, recording day; recording with infrared CCD camera after the onset of disease (0; onset day, 6; day 6 of onset), caloric test: 20 °C, 5 ml irrigation, normal; more than 20 °/s, possible CP; 10–19 °/s, moderate CP; 1–9 °/s, CP; no response [12]).