

Subjective Visual Vertical in Acute Attacks of Meniere's Disease

Kumagami H, Sainoo Y, Fujiyama D, Baba A, Oku R, Takasaki K, Shigeno K, Takahashi H

Department of Otolaryngology – Head and Neck Surgery Nagasaki
University Graduate School of Biomedical Sciences

Address correspondence and reprint requests to Hidetaka Kumagami, M.D.,
Department of Otolaryngology – Head and Neck Surgery Nagasaki
University Graduate School of Biomedical Sciences
Sakamoto 1 – 7 – 1
Nagasaki, Nagasaki, 852 – 8501 Japan

Phone : +81 95 819 7349

Fax : +81 95 819 7352

e-mail : kumagami@nagasaki-u.ac.jp

Abstract

Objectives: To investigate whether or not and how often there is otolith dysfunction in an acute attack of Meniere's disease.

Patients: Twenty-two cases of unilateral Meniere's disease diagnosed in accordance with the 1995 criteria of the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) for Meniere's disease.

Intervention: Subjective visual vertical (SVV) test was performed before, at, and after acute attacks on 22 patients with unilateral Meniere's disease who showed normal tilts of SVV before acute attacks.

Main outcome measure: abnormal tilts of SVV

Results: Fourteen of 22 cases (63.6%) with unilateral Meniere's disease showed abnormal tilts of SVV in acute attacks. The tilts were toward the side of the affected ear in 13 of them (92.9%). Abnormal tilts returned to normal within a few weeks after the acute attacks in 12 of the 14 cases (85.7%) with unilateral Meniere's disease.

Conclusion: Otolith dysfunction occurred in acute attacks in a considerable number of patients with Meniere's disease. SVV can be utilized as a good tool for the evaluation of otolith dysfunction at acute attacks in patients with Meniere's disease.

Keywords: subjective visual vertical; Meniere's disease; acute attack; otolith

dysfunction

Introduction

Subjective visual vertical (SVV) is valued as a clinical test for evaluating the otolithic function and the graviceptive pathways in both peripheral and central vestibular disorders (1-2). With regard to Meniere's disease, studies on changes of SVV after vestibular neurectomy and labyrinthectomy have already been performed (3). However, to our best knowledge, there is no study on SVV in acute attacks of Meniere's disease. Therefore, the prevalence and characteristics of dysfunction of the otolithic organs in an acute attack of Meniere's disease are not yet well understood. The aims of this study are to investigate the prevalence and characteristics of abnormalities of SVV in acute attacks of Meniere's disease and to consider whether a SVV test is available for detecting otolithic dysfunction in Meniere's disease.

Material and Methods

Subjects

Normal subjects

In 51 normal subjects including 32 men and 19 women in age ranging from 21 to 81 years with an average of 44.7, SVV tests were carried out to determine normal range

by using a mean \pm SD (control group).

Patients with Meniere's disease

In patients with Meniere's disease followed at Nagasaki University Hospital between 2005 and 2006, 22 patients with unilateral Meniere's disease (men = 8, women = 14) in age ranging from 24 to 72 years with an average of 38.7 years, were enrolled in the present study. All the patients were diagnosed as definite cases of Meniere's disease in accordance with the 1995 criteria of the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) for Meniere's disease (4).

Vestibular function tests

In all the patients with Meniere's disease (Meniere's group), electronystagmography and caloric testing were performed before an acute attack. In the Meniere's group, before, at, and after an acute attack, whether spontaneous nystagmus was present or not was determined with the use of an infrared video camera (Nagashima Medical Instruments, Japan) and whether ataxia was present or not was evaluated by a stepping test. In caloric tests, canal paresis (CP) was determined according to Jongkees' formula. If the asymmetry found between the response in the left and right ear was >

25%, the result was considered as significant CP. In patients with Meniere's disease, the ear showing a recurrent and fluctuating hearing loss in an acute attack was determined to be the lesion side with reference to clinical data and caloric testing.

Measurement of SVV in patients with Meniere's disease

All the patients with Meniere's disease (Meniere's group) underwent assessment of static SVV before, at, and after an acute attack. In an acute attack, a SVV test was first done within 2 days from the start of the attack and the changes of the tilt of SVV were monitored several times for at least 1 month. Subjects were seated in a chair in a completely dark square room where no other visual clues were present and their head and chin were fixed on a forehead-chin rest in an upright position. A luminous straight bar (length 80 mm, width 10 mm) was back-projected on a large black screen 50 cm in front of the subject. The examinee could freely rotate the bar with a joystick, and once the bar was rotated, they were instructed to use the joystick to bring the bar to vertical. The true vertical orientation was set as 0 degree ($^{\circ}$) and the initial tilt of the bar was randomized before each trial. Tilts of SVV were indicated as angles, and leftward and rightward tilts were represented by negative and positive angles, respectively. Tilts of SVV were measured 6 successive times for each patient and were averaged.

Results

Measurement of SVV in normal subjects

In the control group, SVV tilt was $0.22 \pm 1.26^\circ$ (mean \pm standard deviation), and therefore, the mean \pm 2SD ranged from -2.30 to $+2.74$. Tilts over -2.30 to $+2.74$ were determined to be pathological.

Nystagmus and ataxia in patients with Meniere's disease

Nystagmus and postural imbalance were not observed in all patients before an acute attack. At first evaluation of an acute attack all 22 patients showed spontaneous nystagmus and postural imbalance. Spontaneous nystagmus had subsided in all patients within 4 days.

Measurement of SVV in patients with Meniere's disease

Information about all 22 patients in the Meniere's group is summarized in Table 1. Before an acute attack, none of the 22 patients showed abnormal tilts of SVV. Fourteen of 22 patients (63.6%) exhibited abnormal tilts of SVV (cases one to 14 in

Table 1). Thirteen of those 14 patients (92.9%, cases 1 to 13 in Table 1) showed SVV tilts toward the lesion side and 12 of the 13 patients (92.3%) showed nystagmus directing toward the healthy side. The remaining one (case 14) of the 14 patients showed SVV tilts toward the healthy side, however, nystagmus directed toward the lesion side during acute attack. In 8 of 22 patients (36.3%, cases 15 to 22), SVV tilts remained within the normal range throughout the course. In 12 of the 14 patients (85.7%, cases 3 to 14) SVV tilts normalized within 14 days. Normalization occurred after vertiginous acute attacks had subsided and nystagmus had disappeared in most cases. Whereas, in the remaining 2 patients (15.4%, cases 1 and 2), SVV tilts remained tilted toward the lesion side even after their acute attacks subsided. Of the 12 cases, the 10 with normalized SVV did not complain of vestibular symptoms after their acute attacks subsided. However, the 2 patients with a remaining tilt of SVV complained of dizziness continuously.

SVV and caloric testing in patients with Meniere's disease

Results of SVV were compared to the findings of caloric testing obtained from each patient to determine correlations of abnormalities of SVV with the lateral semicircular canal function of the affected ear. Before an acute attack, CP was

observed in 10 of the 22 cases (45.5%). Six of the 14 cases (42.9%) showing abnormal tilts of SVV in an acute attack had CP and 4 of the 8 cases (50.0%) showing normal SVV in an acute attack had CP. There was no direct relationship between the presence of abnormal tilts of SVV and that of CP ($P>0.999$, Fisher's exact test).

Discussion

In the otolithic organs, utricular condition is speculated to influence SVV more than the saccular condition (5-7). Therefore, SVV has been used as an unilateral utricular function test (8-9). In the present study, almost half of the patients with unilateral Meniere's disease showed abnormal tilts of SVV in an acute attack. There is a high correlation between the direction of SVV tilts and the side that the lesion side is present. Our results may imply that utricular dysfunction occurs or that utricular dysfunction already present worsens in an acute attack of Meniere's disease. However, SVV tilts directed toward the healthy side in one case existed (case 14 in Table 1). In case 14, the ear showing fluctuating hearing loss during the acute attack was determined to be the lesion side. It is known that direct utricular nerve stimulation results in eye torsion away from the stimulated side in cats (10). In humans, ocular torsion is also assumed to be influenced by the utricle more than the saccule, and the magnitude of the

offset of the SVV correlates closely with that of ocular torsion (11-12). Thus, since nystagmus directed toward the lesion side was assumed to be irritative nystagmus, abnormal tilts of SVV toward the healthy side observed in case 14 may imply that excitatory signals were generated in the otolithic organs. However, a further study involving a larger group of patients with Meniere's disease is required to consider the mechanism of abnormal tilts of SVV toward the lesion side.

Regarding the relationship between SVV and caloric testing, it is known that SVV tilts are not correlated with the percentage of CP in vestibular neuritis. Abnormalities of SVV in vestibular neuritis are suggested to depend on the location and extension of the lesion in the vestibular organs and/or nerve (13). Furthermore, in the present study, abnormal tilts of SVV were not correlated with the presence of CP. Although the lateral semicircular canal and the utricle are anatomically connected to the superior vestibular nerve, the semicircular canal function and the utricular function may be differently affected in Meniere's disease.

In the present study, almost all abnormal tilts of SVV occurring in an acute attack returned to normal within 14 days of the acute attack. However, in vestibular deafferentation by vestibular neurectomy and vestibular schwannoma surgery, ipsilesional deviation of SVV lasting months was observed (3,14). After acute attacks

of Meniere's disease, the recovery of SVV tilts observed in acute attacks of Meniere's disease occurred in a shorter time than after surgical vestibular deafferentation. Even though there is central compensation, as an explanation for the rapid recovery of abnormal tilts of SVV in acute attacks, it is assumed to be due to the recovery of the otolithic function, especially the utricle". Clinically, abnormalities of ocular torsion occurring during vertiginous attack of Meniere's disease returned to normal after the end of the attacks (15). Recovery of SVV tilts is speculated to be related to the recovery of ocular torsion due to central compensation and/or recovery of functions of vestibular endorgans. To corroborate this hypothesis, further studies are needed to compare measurements of both methods, i.e. SVV and ocular torsion measurements.

Body rotation, swing, and loading are required in almost all tests of the otolithic function (16). In acute attacks of Meniere's disease, such measurements are practically not feasible. However, the SVV test can assess otolith dysfunction without complex equipment and does not take much time for measurement, nor require stress such as body rotation. Therefore, in the present study almost all patients with Meniere's disease in an attack could take the SVV test without any pain and stress. The SVV test is a simple method to measure the participation of the otolith organs during the acute attack of Meniere's disease. The benefits of the SVV test can be applied more often in

studies of Meniere's disease.

References

1. Gómez García A, Jáuregui-Renaud K. Subjective assessment of visual verticality in follow-up of patients with acute vestibular disease. *Ear Nose Throat J* 2003; 82: 442-446.
2. Dieterich M, Brandt T. Wallenberg's syndrome: lateropulsion, cyclorotation, and subjective visual vertical in thirty-six patients. *Ann Neurol* 1992; 31: 399-408.
3. Vibert D, Häusler R. Long-term evolution of subjective visual vertical after vestibular neurectomy and labyrinthectomy. *Acta Otolaryngol* 2000; 120: 620-622.
4. 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;113:181-185
5. Halmagyi GM, Gresty MA, Gibson WPR. Ocular tilt reaction with peripheral vestibular lesion. *Ann Neurol* 1979; 6: 80-83.
6. Brandt T, Dieterich M. Skew deviation with ocular torsion: a vestibular sign of topographic diagnostic value. *Ann Neurol* 1993; 33: 528-534.

7. Clarke AH, Schonfeld U, Helling K. Unilateral examination of utricle and saccule function. *J Vestib Res.* 2003;13:215-225.
8. Fetter M. Assessing vestibular function: which tests, when? *J Neurol* 2000;247:335-42.
9. Helling K, Schoenfeld U, Clarke AH. Treatment of Meniere's disease by low-dosage intratympanic gentamicin application: Effect on otolithic function. *Laryngoscope* 2007;117:1-7.
10. Suzuki J, Tokumasu K, Goto K. Eye movements from single utricular nerve stimulation in the cat. *Acta Otolaryngol* 1969; 66:350-362.
11. Halmagyi GM, Curthoys IS. Clinical testing of otolith function. *Ann NY Acad Sci.* 1999; 871: 195-204.
12. Curthoys IS, Dai MJ, Halmagyi GM. Human ocular torsional position before and after unilateral vestibular neurectomy. *Exp Brain Res* 1991; 85:218-225.
13. Vibert D, Hausler R, Safran AB: Subjective visual vertical in peripheral unilateral vestibular disease. *J Vestb Res* 1999;9:145-152.
14. Tabak S, Collewyn H, Boumans LJJM. Deviation of the subjective vertical in long-standing unilateral vestibular loss. *Acta Otolaryngol (Stockh)* 1997; 117: 1-6.

15. Oku R, Shigeno K, Kumagami H, Takahashi H. Otolith dysfunction during vertiginous attacks in Ménière's disease. *Acta Otolaryngol* 2003;123:1035-1039.
16. Furman JM, Schor RH, Kamere DB. Off-vertical axis rotational responses in patients with unilateral vestibular lesions. *Ann Otol Rhinol Laryngol* 1993; 102: 137-143.

Figure legends

Figure 1. Time course of tilts of the 14 of 22 patients with unilateral Meniere's disease showing abnormal tilts of SVV. Thirteen of the 14 patients showed SVV tilts toward the lesion side. In 12 of the 14 patients, SVV tilts normalized within 14 days. Day 0 = before attack. Day 1 = the onset day of the acute attack. Gradations of day mean how many days have passed since the onset day of the acute attack. * = tilts toward the healthy side.

Table 1. Summary of 22 patients with Meniere's disease

Case (No.)	Age (year)	Gender	Affected side	Nystagmus (direction)	Caloric	SVV(degree)		
						before attack	attack	after attack
1	42	M	Right	Left	CP	2.3	8.9	8.1
2	49	M	Right	Left	CP	1.5	9.8	6.2
3	24	W	Right	Left	N	1.8	6.8	-1.8
4	42	W	Right	Left	N	1.8	6.6	1.6
5	36	M	Right	Left	CP	1.3	10.2	1.5
6	39	W	Right	Left	CP	1.3	8.3	0.7
7	41	W	Right	Left	CP	1.1	6.1	-0.9
8	38	W	Right	Right	N	2.2	9.7	-1.8
9	42	M	Left	Right	N	1.3	-4.2	1.6
10	32	M	Left	Right	N	-1.2	-7.5	-1.8
11	37	W	Left	Right	CP	-1.5	-8.9	-2.3
12	32	M	Left	Right	N	1.0	-7.9	-1.3
13	41	W	Left	Right	N	-1.8	-8.9	-1.3
14	43	M	Right	Right	N	1.3	-4.2	1.6
15	39	W	Right	Left	CP	-1.8	-2.1	1.9
16	42	M	Right	Left	CP	1.8	1.4	1.5
17	46	W	Right	Left	N	-1.6	-1.9	-0.8
18	41	M	Right	Left	N	1.6	1.5	1.1
19	53	M	Left	Right	CP	1.9	1.7	-0.5
20	33	M	Left	Right	CP	-1.3	-1.8	1.3
21	33	W	Left	Right	N	1.6	1.5	-1.8
22	72	W	Left	Right	N	1.8	1.7	1.7

In 22 patients with unilateral Meniere's disease, 14 patients showed abnormal tilts of

SVV in an acute attack. Of the 14 patients, 13 patients showed abnormal tilts

toward the lesion side. The direction of nystagmus was the finding on the first day

when nystagmus was observed in an acute attack. The caloric response presented

in the table is the finding observed before an acute attack. M=Man, W=Woman,
CP=Canal Paresis, N=Normal, SVV=Subjective Visual Vertical

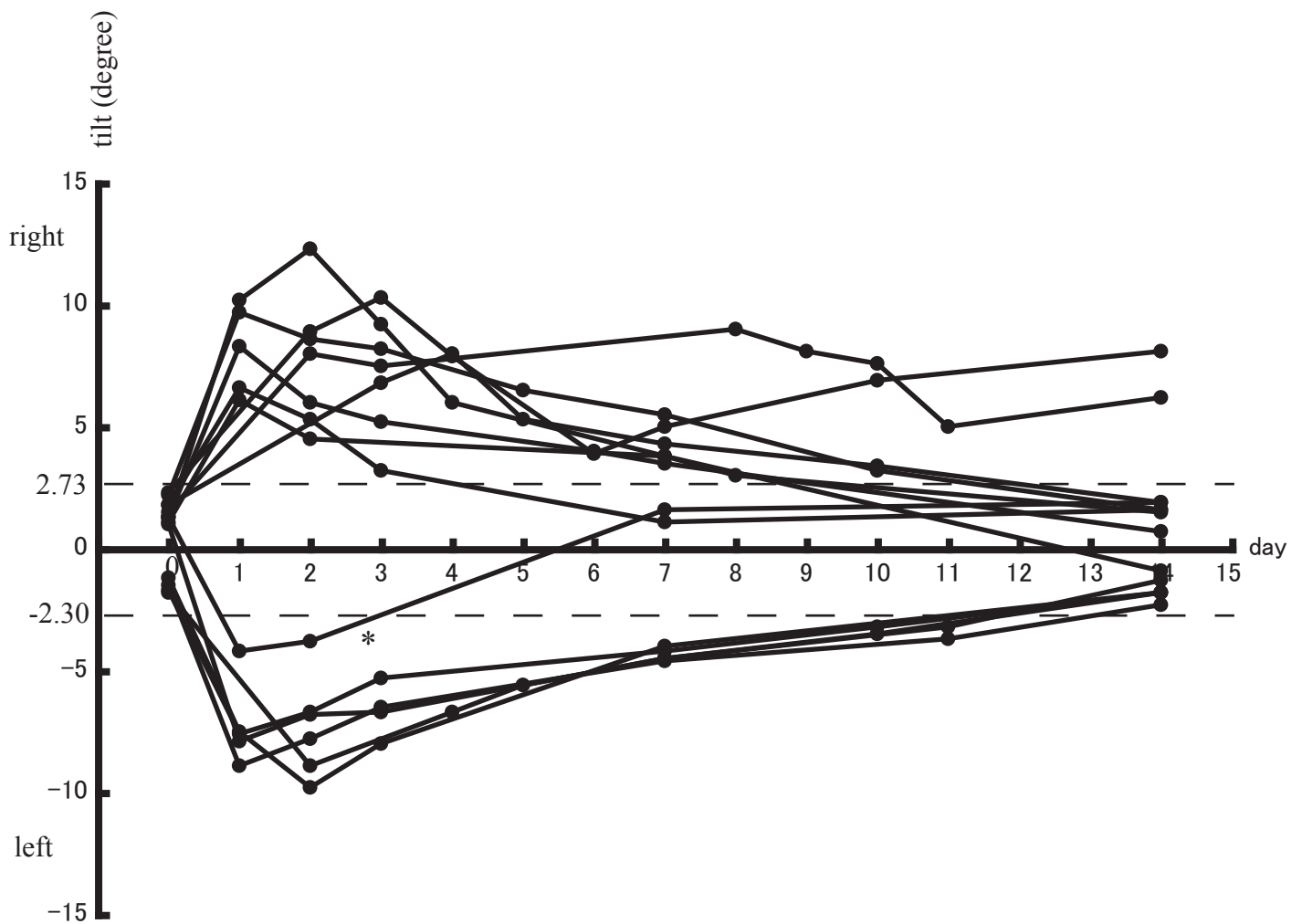


Figure 1. Time course of tilts of the 14 of 22 patients with unilateral Meniere's disease showing abnormal tilts of SVV. Thirteen of the 14 patients showed SVV tilts toward the lesion side. In 12 of the 14 patients, SVV tilts normalized within 14 days. Day 0 =before attack. Day 1 = the onset day of the acute attack. Gradations of day mean how many days have passed since the onset day of the acute attack. * = tilts toward the healthy side.