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Correlation between the dizziness handicap inventory and balance performance during the acute phase of unilateral vestibulopathy

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ABSTRACT

Purpose: The dizziness handicap inventory (DHI) is widely used to evaluate self-perceived handicap due to dizziness, and is known to correlate with vestibular function tests in chronic dizziness. However, whether DHI reflects subjective symptoms during the acute phase has not been studied. This study aims to investigate the correlations of subjective and objective measurements to highlight parameters that reflect the severity of dizziness during the first week of acute unilateral vestibulopathy.

Materials and methods: Thirty-seven patients with acute unilateral vestibulopathy were examined. Patients' subjective perceptions of dizziness were measured using the DHI, Vertigo Visual Analog Scale (VVAS), Disability Scale (DS), and Activity-Specific Balance Scale (ABC). Additionally, the oculomotor tests, Romberg and sharpened Romberg tests, functional reach test, and dynamic visual acuity tests were performed. The correlation between the DHI and other tests was evaluated.

Results: DHI-total scores exhibited a moderately positive correlation with VVAS and DS, and a moderately negative correlation with ABC. However, DHI-total score did not correlate with results of the Romberg, sharpened Romberg, or functional reach tests. When compared among four groups divided according to DHI scores, VVAS and DS scores exhibited statistically significant differences, but no significant differences were detected for other test results.

Conclusion: Our findings revealed that the DHI correlated significantly with self-perceived symptoms measured by VVAS and DS, but not ABC. There was no significant correlation with other balance function tests during the first week of acute vestibulopathy. The results suggest that DHI, VVAS and DS may be more useful to measure the severity of acute dizziness symptoms.

1. Introduction

The objective assessment of dizziness symptoms remains a challenge for both physicians and patients who are experiencing dizziness. Dizziness is a subjective symptom that is characterized by an individual's perceived sense of spinning motion, loss of balance, or feelings of lightheadedness. A patient who is experiencing dizziness often suffers from limitations in various common daily activities. Some measures such as the frequency and duration of dizziness attacks, the

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observation of nystagmus, and the number of falls are quantifiable and can be used to assess the severity of dizziness. However, these measurements may not necessarily correlate with the severity of self-perceived dizziness.

The Dizziness Handicap Inventory (DHI) was developed to evaluate self-perceived handicaps due to dizziness [1]. DHI is a global self-assessment tool that has been translated into many languages, including Korean [2]. DHI is used to identify specific functional, emotional, or physical problems imposed by vestibular impairment, and has proven to be a reliable tool for assessing the therapeutic effects of vestibular rehabilitation [1,3]. Previous studies have reported correlations between DHI scores and the results of dynamic posturography [4,5], electronystagmography [5], and dynamic gait index [4–7]. However, these studies were designed to include patients who experienced chronic dizziness symptoms arising from various etiologies such as benign paroxysmal postural vertigo, vestibular neuritis, bilateral vestibular loss, Meniere's disease, and chronic nonspecific dizziness. Since they have experienced subjective dizziness over prolonged periods, patients with chronic dizziness symptoms are likely to develop specific adaptations to their daily routine in order to evade aggravation of dizziness caused by certain head or body movements. The DHI scores reflect such dizziness-related handicap perceived by the patients. Conversely, acute unilateral vestibulopathy patients experience a sudden onset of severe dizziness, but the symptoms usually dissipate over time. Since the dizziness symptoms occur quite suddenly in patients with no prior history, coping with dizziness during the acute phase can be quite challenging. In the current study, we evaluated whether the subjective perception of dizziness reflected functional impairment during the acute phase of unilateral vestibulopathy. The study was designed to investigate the correlation of the self-perceived dizziness handicap, as measured by DHI, to various vestibular tests and other self-reported indications during the initial onset of symptoms in acute unilateral vestibulopathy patients.

2. Materials and methods

A prospective multicenter study was performed in five referral university hospitals (Incheon St Mary's Hospital, Uijeongbu St. Mary's Hospital, St. Paul's Hospital, and Bucheon St. Mary Hospital of the Catholic University of Korea and Yonsei University Gangnam Severance Hospital) from April 2013 to February 2014. Institutional review boards in each respective hospital approved the study. Patients who presented with acute onset of severe vertigo at the emergency department or ENT clinic and diagnosed with acute unilateral vestibulopathy were enrolled. Inclusion criteria of this study were sudden onset of acute vertigo lasting more than one day, no accompanying hearing difficulty, and no other neurologic symptoms or signs. Exclusion criteria were age <18 or >65, onset of acute vertigo more than seven days ago, central origin vertigo, a history of head trauma, accompanying otologic diseases (including, but not limited to otitis media and otosclerosis), a history of recurrent vertigo (including benign paroxysmal positional vertigo and Meniere's disease), accompanying musculoskeletal condition that limits physical examination or vestibular rehabilitation therapy, or lack of consent. Of the 51 patients who were eligible for the study, 14 patients were excluded, and 37 patients diagnosed with acute vestibulopathy were included into the statistical analysis. A complete and thorough history and physical examination were performed at the initial visit that was conducted within seven days of the sudden vertigo symptoms.

2.1. *Subjective measures of dizziness*

Several subjective evaluations of dizziness symptoms were performed at the initial visit. The patients' subjective perception of dizziness related handicaps in daily activities was measured using the Korean version of the Dizziness Handicap Inventory (DHI), which measures self-perceived handicaps resulting from the functional, emotional, and physical aspects of dizziness, using a 25 item questionnaire [1,2]. The DHI-total score ranges from 0 (no dizziness handicap) to 100 (maximum dizziness handicap). The DHI scores are subcategorized as functional (DHI-F, 36 points), emotional (DHI-E, 36 points), and physical (DHI-P, 28 points). Self-perceived dizziness handicaps were grouped according to DHI scores, and classified as minimal (0–14), mild (16–34), moderate (36–52), and severe (≥54).

During the initial visit, the patients indicated their feeling of dizziness on a Vertigo Visual Analog Scale (VVAS) ranging from 0 (no dizziness) to 10 (maximum dizziness). As well, the patient's perception of disability caused by dizziness was noted on the Disability Scale (DS) [6]. The DS is 6-point scale that ranges from 0 (no disability) to 5 (having a long-term disability). The Activity-specific Balance Scale (ABC) is a 16-item questionnaire that documents the patient's perceived confidence performing 16 specific daily activities on a scale of 0% (no confidence) to 100% (100% confident) [7].

2.2. *Vestibular function tests and balance examination*

Physical examinations included otomicroscopy, neurologic test and oculomotor tests (presence or absence of spontaneous nystagmus, gaze-evoked nystagmus, and head shaking-induced nystagmus). In addition, the canal paresis (%) and directional preponderance (%) of the bithermal caloric irrigation test was measured.

Static balance tests included Romberg and sharpened Romberg tests conducted with the eyes both opened and closed. During Romberg test, the patient is asked to stand on the floor, preferably with shoes off, feet together. Patient is asked his or her arms crossed on the chest. The amount of time in seconds able to maintain the position is timed, first tested with eyes open, and then eyes closed. During sharpened Romberg test, patient is asked to stand with one foot directly in front of the other foot, heal touching toe.

Dynamic balance was evaluated by performance of the functional reach test (FRT) [8] and the dynamic visual acuity (DVA) test [5]. During functional reach test, the patient is instructed to stand next to, but not touching a wall. Then the patient closes one's fist, stretches his or her arm along the wall being parallel to the floor. The examiner records the starting position at the 3rd metacarpal head on the yardstick and instructs the patient to reach as far as he or she can forward without taking a step. The location of the 3rd metacarpal at this step is again recorded and the difference between the starting and the end position is calculated. Three

Table 1 – Summary of clinical data for the 37 patients. The data are expressed as mean ± standard deviation.

Age (years)	50.9 ± 11.3
Gender (M:F)	16:21
DHI scores	
Total DHI	52.1 ± 31.9
DHI-physical	15.4 ± 8.9
DHI-functional	20.8 ± 14.2
DHI-emotional	16.6 ± 12.2
Vertigo Visual Analog Scale	6.9 ± 3.0
Disability Scale	2.5 ± 1.2
Activity-specific Balance Confidence Scale	49.2 ± 30.2
Presence of spontaneous nystagmus (%)	68.3
Presence of gaze-evoked nystagmus (%)	65.9
Romberg test	
Eyes open (sec)	28.3 ± 5.4
Eyes closed (sec)	24.8 ± 9.6
Sharpened Romberg test	
Eyes open (sec)	22.8 ± 10.6
Eyes closed (sec)	9.5 ± 1.0
Functional reach test (cm)	28.3 ± 9.8
Positivity of dynamic visual acuity (%)	22.0
Caloric paresis (%)	57.5 ± 24.0

DHI: Dizziness Handicap Inventory.

trials are done and their average is used for the FRT data. Before dynamic visual acuity (DVA) test, static visual acuity is measured with the head still. Visual acuity is then determined while the patient's head is oscillated manually to a 2 Hz beat sound generated from metronome. A loss of three or more lines of dynamic visual acuity relative to one's static visual acuity is regarded as clinically significant abnormality.

2.3. *Data analysis*

Probability values of $P < 0.05$ were considered statistically significant. All statistical analyses were performed using IBM®-SPSS® statistical software (version 19, IBM Corporation, New York, NY), and the data were expressed as the mean ± standard deviation.

Table 2 – The correlation between the DHI scores and other self-perceived dizziness scales (VVAS, DS and ABC), as well as objective measures of balance tests (Romberg test, sharpened Romberg test, functional reach test; n = 37).

	DHI	Pearson's correlation coefficients
VVAS	$P < 0.0001$	$R = 0.657$
DS	$P < 0.0001$	$R = 0.574$
ABC	$P = 0.022$	$R = -0.403$
Romberg test		
Eyes open	$P = 0.205$	
Eyes	$P = 0.217$	
Sharpened Romberg test		
Eyes open	$P = 0.230$	
Eyes closed	$P = 0.360$	
Functional reach test	$P = 0.523$	

DHI: Dizziness Handicap Inventory, VVAS: Vertigo Visual Analog Scale, DS: Disability Scale, ABC: Activity-specific Balance Confidence Scale.

Differences in the numerical values among three or more groups were tested using the Kruskal–Wallis test. The independence of two groups was tested using Pearson's chi-square test. Spearman correlation analysis was used to identify linear associations between two variables.

2.4. *Ethical considerations*

The institutional review boards of each hospital approved the study, and written informed consent was obtained from each patient prior to enrollment.

3. Results

In total, 37 patients were included in the study. Clinical data including the DHI scores (total and subscale scores), the scores for self-reported indications of dizziness (VVAS, DS, and ABC), and physical examination results are summarized in Table 1.

The DHI-total scores exhibited statistically significant correlations with VVAS (rho = 0.657) and DS (rho = 0.574) that were moderately positive, as well as a significant moderate negative correlation with ABC (rho = −0.403; Table 2). DHI subscales (DHI-F, DHI-E, and DHI-P) showed similar correlations with VVAS, DS and ABC. However, no statistically significant correlations were detected between the DHI and the results of the Romberg, sharpened Romberg, or functional reach tests (Table 2). The duration of time the patient is able to maintain the position while eyes are either open or closed during Romberg and sharpened Romberg tests were not correlated with DHI. The length of FRT was not correlated with DHI. DHI subscales (DHI-F, DHI-E, and DHI-P) did not show correlation with the results of the Romberg, sharpened Romberg, or FRT (data not shown).

The patients were divided into four groups based on the severity of self-reported handicaps, as indicated by DHI scores. VVAS and DS scores exhibited statistically significant differences among four groups, but there was no significant difference in the objective measures of the balance tests among the four DHI groups (Table 3).

4. Discussion

The DHI is most widely used tool for measuring self-perceived handicap caused by dizziness in daily life [1]. Accurate assessment of dizziness symptoms is mandatory not only for measuring the negative impact on the patients' daily lives, but also for evaluating the progress of balance disorder treatments. Numerous studies have attempted to determine the correlation of the severity of subjective dizziness and objective measurements of balance performance [9–13]. A recent review proposed that the correlation between the DHI scores and several vestibular test results are quite varied. Specifically, some tests (e.g. computerized dynamic posturography, functional reach, electronystagmography, dynamic gait index, and head impulse test) were reported to have a strong correlation to DHI scores, while others were reported to have a moderate/weak correlation (e.g. single leg stance, timed up and go, rotation chair, and Romberg test), or

Table 3 – A comparison of self-perceived dizziness scales (VVAS, DS and ABC) and objective measures of balance tests (Romberg test, sharpened Romberg test, functional reach test) among the four DHI groups classified by severity of handicap related to dizziness (n = 37). The data are expressed as mean ± standard deviation.

	Minimal DHI 0–15 (n = 6)	Mild DHI 16–34 (n = 7)	Moderate DHI 36–52 (n = 6)	Severe DHI ≥ 54 (n = 18)	P-value
Age (years)	52.2 ± 8.3	53.3 ± 8.5	50.7 ± 15.8	49.6 ± 12.0	
Gender (M:F)	2:4	2:5	3:3	9:9	
VVAS (0–10)	3.8 ± 3.5	5.3 ± 2.6	6.5 ± 3.0	8.7 ± 1.5	0.001*
DS (0–5)	0.7 ± 0.8	2.3 ± 0.8	2.8 ± 1.0	3.0 ± 1.0	<0.0001*
ABC (0–100%)	65.0 ± 46.3	61.5 ± 22.0	39.5 ± 21.8	42.4 ± 25.9	0.298
Presence of spontaneous nystagmus (%)	50.0	57.1	83.3	72.2	0.562
Presence of gaze-evoked nystagmus (%)	50.0	50.0	80.0	82.4	0.284
Presence of head-shaking nystagmus (%)	16.7	14.3	16.7	22.2	0.966
Romberg test					
Eyes open (sec)	28.3 ± 4.1	30.0 ± 0.0	30.0 ± 0.0	26.7 ± 7.5	0.453
Eyes closed (sec)	28.3 ± 4.1	26.3 ± 9.8	24.7 ± 8.6	22.2 ± 11.6	0.564
Sharpened Romberg test					
Eyes open (sec)	25.8 ± 10.2	25.9 ± 11.0	24.2 ± 10.2	19.0 ± 11.1	0.367
Eyes closed (sec)	11.2 ± 11.1	12.3 ± 13.7	11.0 ± 10	8.7 ± 9.0	0.861
Functional reach test (cm)	31.5 ± 9.1	27.7 ± 10.7	27.0 ± 6.1	27.6 ± 11.7	0.861
Presence of abnormal DVA (%)	33.3	14.3	33.3	22.2	0.812

DHI: Dizziness Handicap Inventory, VVAS: Vertigo Visual Analog Scale, DS: Disability Scale, ABC: Activity-specific Balance Confidence Scale, DVA: dynamic visual acuity.

no correlation (e.g. foam surface conditions on modified clinical test for the sensory interaction on balance test, caloric response, and cervical vestibular evoked myogenic potentials) [4,5,10,14]. In short, quantitative measurements of the patients' performance do not necessarily correlate with self-perceived dizziness handicaps. In fact, the self-perception of dizziness may differ according to several clinical factors. It is worth noting that most studies compared the DHI scores and vestibular tests in groups of patients with various etiologies, most of whom suffered from chronic dizziness or balance problems. Self-perceived handicap related to dizziness may differ among the patients suffering from acute or chronic dizziness. During the acute stage of vestibulopathy, patients are easily overwhelmed not only by the symptoms of vertigo, but also by the unexpected and sudden onset of the disease. Another drawback to interpretation of DHI in the acute stage of unilateral vestibulopathy is that the patients may not have yet experienced the burden of dizziness when performing the various conditions specified on the questionnaire. Conversely, patients suffering from chronic dizziness have established experience with dizziness hindering their performance of the daily activities included in the DHI.

In this study, we focused on the initial phase of acute unilateral vestibulopathy. The results indicated that the total DHI scores were correlated with subjective measures such as VVAS, DS, and ABC scores. This discrepancy may be explained by the abrupt nature of the onset of symptoms. Since the VVAS and DS categorize the severity of dizziness symptoms, their correlation to the DHI scores could be expected. However, the ABC measures the subjective confidence of balance control during various daily activities [7]. Accordingly, it may not be initially apparent to the patients with acute dizziness that their symptoms may affect their balance confidence, whereas the effects are more evident to patients with chronic dizziness. Although we expected to find that some of the balance performance tests were correlated with the self-perceived dizziness handicap, the results of vestibular tests included in the protocol failed to correlate with either the total DHI scores or the subscale scores. These findings suggest that the self-perceived symptoms do not necessarily reflect the severity of vestibular function impairment during the acute phase. Rather, the initial hardship experienced by the patients might be related to their response to the traumatic experience of severe dizziness. Therefore, when evaluating psychological stress, the use of other psychometric tools in addition to DHI may provide a more comprehensive measurement of subjective symptoms during the acute phase of unilateral vestibulopathy.

One of the limitations of our study was that dynamic balance evaluations such as the dynamic gait index or walking test were not included in the battery of balance tests. Although we did not detect a significant correlation between the DHI scores and the FRT or DVA tests, the associated test results provided additional information regarding the relationship between the self-perceived dizziness handicaps and static balance function of the patients, which is fundamental for daily activities. Future studies are needed to evaluate whether the relationship between self-perceived handicaps related to dizziness and balance test results change over time in acute vestibulopathy patients, and whether initial DHI may predict resolution or continuation of symptoms over the course of the disease.

5. Conclusion

In summary, our findings indicated that DHI correlated well with other subjective assessment by VVAS and DS. This study failed to show any correlation between DHI and ABC scores, which can measure subjectively patient's confidence in performing various ambulatory activities without falling or experiencing a sense of unsteadiness. Our results also found

that DHI scores did not correlate with several balance function tests during the first week of acute vestibulopathy. Therefore, we suggest that psychological factors, together with vestibular/balance-related dysfunction, can influence the patient's subjective disability and comprehensive assessment including subjective tools as well as objective vestibular/balance function tests can evaluate the status of dizzy patient.

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