Fatigue Related Dizziness

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ABSTRACT

Objective: To verify whether fatigue is related with dizziness, we examined 72 patients between 20 and 65 years old who had new onset of daily dizziness for less than one month and in whom known causes of dizziness were excluded after extensive evaluation (acute unexplained dizziness [AUD] group).

Methods: We used scales to estimate the severity of dizziness, fatigue, sleep quality, anxiety, and depression. For comparison, we administered the same scales to 52 patients with benign paroxysmal positional vertigo (BPPV group).

Results: The AUD group reported higher levels of fatigue and anxiety than the BPPV group. More than half of the patients in the AUD group experienced fatigue. Fatigue and anxiety were strong predictors of the dizziness score. Fatigue severity correlated with insomnia severity, consistent with fatigue as a manifestation of insufficient sleep.

Conclusions: From these findings, we infer that fatigue was the cause of dizziness in the majority of patients in the AUD group and that anxiety in these patients may be secondary to dizziness. Our preliminary data indicate the need to further investigate fatigue as a cause of dizziness.

Keywords: Dizziness, Fatigue, Anxiety, Dizziness Handicap Inventory, BPPV

Introduction

Dizziness and vertigo are prevalent conditions among outpatients (Kroenke and Mangelsdorff, 1989). Dizziness is defined as the sensation of disturbed spatial orientation without a false or distorted sense of motion, while vertigo is the sensation of self-motion when no self-motion or normal head movement is occurring (Bisdorff *et al.*, 2009). In practice, it is not difficult to separate dizziness from vertigo (Ropper and Samuels, 2009). While vertigo indicates disease of the semicircular canals or their central nervous system (CNS) connections, (Bronstein and Lempert, 2013) identifying the cause of dizziness on the basis of symptoms is more difficult because central and peripheral vestibular disorders, as well as non-vestibular syndromes such as visual vertigo, presyncopal faintness, or psychosomatic

disorders, are all possible diagnoses (Brandt, 2000).

Fatigue is a commonly reported symptom in primary care patients (Nijrolder *et al*, 2009). Among community-dwelling adults aged 51 and above, the prevalence of fatigue was estimated at 31.2% (Meng et a., 2010). Fatigue is defined as difficulty in initiating or sustaining voluntary activities due to the perception of tiredness or exhaustion (Penner and Paul, 2017). In the healthy population, transient fatigue is an ephemeral phenomenon provoked by excessive exertion that diminishes with rest and does not interfere with usual daily activities (Finsterer and Mahjoub, 2014). Fatigue is a frequent complaint among outpatients who present with dizziness (Nijrolder *et al*, 2009). Fatigue may be a causative factor of dizziness, an epiphenomenon of vestibular disorders, or an independent symptom that is unrelated to dizziness. The uncertain pathology and high prevalence make it challenging to clarify the relationship between fatigue and dizziness. We sought to investigate the prevalence of fatigue in acute dizziness with unknown cause and postulate the role of fatigue in patients with dizziness.

Materials and Methods

Participants

Subjects

We recruited patients with acute unexplained dizziness (AUD) between 20 and 65 years old who had 1) spontaneous dizziness for less than one month, 2) continuous dizziness, 3) normal results of neuro-otological testing including video-oculography and other relevant tests (see Examinations, below), and 4) no history of previous dizziness. We excluded the patients who had 1) a history of vestibular migraine based on the clinical diagnostic criteria, (Neuhauser *et al*., 2001) 2) anxiety or depressive disorders based on the relevant diagnostic criteria, (Anxiety disorders, 2000; Mood disorders, 2000) or 3) identifiable neurological, psychiatric, cardiac, visual, or somatosensory problems or other medical conditions that could potentially cause dizziness. For comparison, we enrolled patients who had benign paroxysmal positional vertigo (BPPV) based on 1) a history of positional vertigo, 2) positional nystagmus with Frenzel goggles, and 3) resolution by repositioning maneuvers.

Examinations

Neuro-otological testing was performed using Frenzel goggles and video-nystagmography. Patients who had spontaneous nystagmus or nystagmus provoked by positional change, head shaking, the head impulse test, hyperventilation, or tragal compression were excluded from the AUD group. BPPV was diagnosed based upon the clinical presentation, neuro-ophthalmologic evaluation including

positional maneuvers, and response to canalith repositioning therapy. We also performed caloric testing, vestibular evoked myogenic potentials, tilt table testing, and nerve conduction studies to exclude other causes of dizziness.

Evaluations

Each participant with dizziness was assessed using the following five scales to evaluate the severity of dizziness, fatigue, insomnia, anxiety, and depression: Dizziness Handicap Inventory (DHI), Fatigue Severity Scale (FSS), Insomnia Severity Index (ISI), Beck Anxiety Index (BAI), and Beck Depression Index-II (BDI-II), respectively. The patients with BPPV were assessed using the same five scales before repositioning maneuvers. All the questionnaires given to the patients were validated Korean versions (Han *et al.*, 2004; Chung and Song, 2001; Cho *et al.*, 2014; Yook and Kim, 1997; Sung *et al.*, 2008). We received written informed patient consents to perform this study.

The DHI is a self-report questionnaire that evaluates the impact of dizziness and unsteadiness on quality of life. It consists of 25 items that are divided into a 7-item physical subscale, a 9-item emotional subscale, and a 9-item functional subscale. The total score ranges from 0 (no handicap) to 100 (severe handicap) (Jacobson and Newman, 1990). A total score above 60 points indicates severe handicap (Whitney *et al.*, 2004).

The FSS is a 9-item self-report questionnaire that assesses the degree to which fatigue influences function and behavior and provides a measure of daytime fatigue. Possible scores range from 1 to 7, with higher scores reflecting greater fatigue. We adopted a score of 3 as the cutoff for a normal result, with higher values implying pathologic fatigue (Hossain *et al.*, 200). Scores between 4 and 4.9 are considered to reflect moderate fatigue, while scores of 5 and above reflect severe fatigue (Pollak and Stryjer, 2015).

The ISI is a self-report questionnaire that measures the perceived severity of insomnia. The ISI comprises seven items that evaluate difficulty falling asleep and staying asleep, waking too early, satisfaction with current sleep patterns, interference with daily functions, noticeability of impairment attributed to sleep problems, and distress caused by sleep problems. The total ISI score is divided into four insomnia categories: not clinically significant (scores of 0–7), subthreshold (scores of 8–14), moderate (scores of 15–21), and severe (scores of 22–28) (Morin *et al.*, 2009).

The BAI is a 21-item self-report questionnaire that measures the severity of anxiety. Respondents are asked to report the extent to which they have been bothered by each symptom during the preceding week. The total BAI score is divided into four categories of anxiety severity: minimal (scores of 0–7),

mild (scores of 8–15), moderate (scores of 16–25) and severe (scores of 26–63) (Beck *et al.*, 1988).

The BDI-II questionnaire comprises 21 items assessing the symptoms and level of depression. Respondents are asked to choose one of four descriptions that best fit how they have been feeling over the past 2 weeks. The total BDI-II score is divided into four depression categories: minimal (scores of 0–13), mild (14–19), moderate (scores of 20–28), and severe (scores of 29–63) (Beck *et al.*, 1996).

Statistics

IBM SPSS Statistics for Windows version 21.0.0 was used to analyze the data. Pearson's correlations were employed to investigate the relationships between clinical variables and the DHI score. The demographic data and validated scores including those on the DHI, FSS, ISI, BAI, and BDI-II were also compared between the patient groups using Student's t-tests. Chi-square tests were used to compare categorical variables. Multiple regression testing was used to determine factors associated with dizziness severity and to find relationships between dizziness severity and other variables. Statistical significance was set at $p < 0.05$.

The study was performed in accordance with the Declaration of Helsinki and approved by the institutional review board of the Kyungpook National University. Written informed consents were obtained from all participants (or guardians of participants) in this study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, BIH, upon reasonable request.

Results

Demographic and clinical characteristics are shown in Table 1. We enrolled 72 patients with dizziness in the AUD group (age = 43.5 ± 14.1 years; 31 males) and 52 patients with BPPV in the BPPV group (age = 49.5 ± 11.2 years; 19 males). The symptom durations of the two groups were 13.2 ± 10.5 days and 6.9 ± 10.7 days respectively. There was no significant sex difference between the groups (p=0.586), but there were differences in age (p=0.012) and symptom duration (p=0.001) (Table 1). In the BPPV group, 29 patients had posterior canal involvement (Rt:Lt=14:15) and 23 had horizontal canal involvement (Rt:Lt=13:10).

Differences between the AUD group and the BPPV group are shown in Table 1. The AUD group had higher fatigue and anxiety scores compared to the BPPV group, while there were no significant

differences in DHI, ISI, and BDI-II scores (Table 1). The mean FSS of the AUD group was 3.1 ±1.9; 42 patients (58.33 %) had fatigue when the cutoff for a normal value was set at FSS ≥ 3. The mean BAI score of the AUD group was 15.8 ± 12.3. Twenty-nine of the AUD group patients (40.28%) had moderate to severe anxiety when the BAI cutoff score was set at 16. The mean BAI score of the BPPV group was 10.6 ± 9.2 and the BDI-II score was 9.9 ± 8.2, whereas the FSS and ISI scores were within normal range.

Table 1. Demographic and clinical characteristics. The AUD group patients were older, had a longer symptom duration, and had higher anxiety and fatigue scores compared to the BPPV group patients (p=0.012, 0.001, 0.008, and 0.008, respectively), while there were no significant differences in sex and DHI, ISI, and BDI-II scores (p=0.586, 0.739, 0.085, and 0.083, respectively).

Group	BPPV (N=52)	AUD (N=72)	*p*
Age, years	49.5 ± 11.2	43.5 ± 14.1	0.012
Sex (%)			0.586
Female	33 (63.5%)	41 (56.9%)	
Male	19 (36.5%)	31 (43.1%)	
Symptom duration, days	6.9 ± 10.7	13.2 ± 10.5	0.001
DHI	21.8 ± 15.6	22.9 ± 18.4	0.739
FSS	2.2 ± 1.7	3.1 ± 1.9	0.008
ISI	7.2 ± 5.2	9.1 ± 6.7	0.085
BAI	10.6 ± 9.2	15.8 ± 12.3	0.008
BDI-II	9.9 ± 8.2	12.8 ± 9.4	0.083
BPPV, benign paroxysmal positional vertigo; AUD, acute unexplained dizziness; DHI, Dizziness Handicap Inventory; FSS, Fatigue Severity Scale; ISI, Insomnia Severity Index; BAI, Beck Anxiety Index; BDI-II, Beck Depression Index-II.			

Correlations between the DHI score and other variables in the AUD group are shown in Table 2. The fatigue, insomnia, anxiety, and depression scores each had a significant positive correlation with the DHI score (p=0.001), while age and symptom duration did not (p=0.092 and 0.688, respectively) (Table 2). The FSS score correlated with the ISI score in the AUD group, but this correlation was not seen in the BPPV group (data not shown). The predictors for the DHI score in the AUD group are shown in Table 3. Multivariate analyses delineated the strongest predictor as the BAI (ß=0.495, p=0.002), followed by the FSS (ß=0.249, p=0.027) (Table 3).

Variable differences after fatigue treatment in the AUD group are shown in Table 4. In the AUD group, follow-up data were collected on the second visit after education and medications were provided to the patients to relieve fatigue or sleep-related problems. Only 19 patients in the AUD group had the second visit within 7 to 14 days after the first visit. The rest of the patients declined to return to our clinic because their dizziness rapidly disappeared and they did not feel that a return visit was necessary. The follow-up data showed significant improvement not only in the DHI score, but also in the FSS and BAI scores compared to those from the initial visits (p=0.03, 0.009, and 0.01, respectively) by the paired t-test (Table 4).

Table 2. Pearson's correlations between the DHI and variables in patients with AUD. The fatigue, insomnia, anxiety, and depression scores each had a significant positive correlation (p=0.001) with the DHI score, while age and symptom duration did not (p=0.092 and 0.688 respectively).

	r	*p*
Age	−0.200	0.092
Symptom duration	0.048	0.688
FSS	0.527	<0.001
ISI	0.438	<0.001
BAI	0.65	<0.001
BDI-II	0.552	<0.001
DHI, Dizziness Handicap Inventory; AUD, acute unexplained dizziness; FSS, Fatigue Severity Scale; ISI, Insomnia Severity Index; BAI, Beck Anxiety Index; BDI-II, Beck Depression Index-II. Bold face indicates statistical significance.		

Table 3. Multiple regression analysis of variables associated with the DHI in patients with AUD. The strongest predictor was the BAI (ß=0.495, p=0.002), followed by the FSS (ß=0.249, p=0.027).

Variable	Standardized coefficient (ß)	*p*	Collinearity VIF	R^2
Constant		<0.001		0.469
FSS	0.249	0.027	1.519	
ISI	0.093	0.427	1.715	
BAI	0.495	0.002	3.08	
BDI-II	-0.45	0.785	3.409	
DHI, Dizziness Handicap Inventory; AUD, acute unexplained dizziness; FSS, Fatigue Severity Scale; ISI, Insomnia Severity Index; BAI, Beck Anxiety Index; BDI-II, Beck Depression Index-II.				

Table 4. Variable differences in the 7 to 14-day interval after symptom onset in patients with AUD. Significant improvement was observed in DHI, FSS, and BAI scores compared with those from the initial visits (p=0.03, 0.009, and 0.010, respectively) by the paired t-test.

Variables	Visit 1 (N=19)	Visit 2 (N=19)	p
DHI	26.3 ± 17.3	15.0 ± 13.6	0.03
FSS	3.5 ± 1.9	2.5 ± 1.6	0.009
ISI	10.2 ± 7.7	8.9 ± 6.7	0.228
BAI	20.6 ± 15.1	13.6 ± 11.4	0.01
BDI-II	17.3 ± 11.7	13.9 ± 11.8	0.071
AUD, acute unexplained dizziness; DHI, Dizziness Handicap Inventory; FSS, Fatigue Severity Scale; ISI, Insomnia Severity Index; BAI, Beck Anxiety Index; BDI-II, Beck Depression Index-II. Paired t-test was used.			

The patients in the AUD group showed distinct clinical characteristics. The patients were usually sleep-deprived or overworked (e.g., shift workers, students preparing for college, mothers or grandmothers taking care of their young children or grandchildren). The symptoms were a sense of floating or unsteadiness starting 1 or 2 hours after waking up or working at the jobsite.

The dizziness lasted all day with fluctuating but slowly increasing intensity over time and worst in the late afternoon. In some patients, the dizziness lasted several minutes (usually 1 to 10 minutes)

followed by a symptom-free period lasting several minutes, with the dizziness cycle occurring several times an hour. Pain in the head and neck sometimes accompanied the dizziness, but nausea did not. The dizziness usually disappeared while the patients were concentrating on certain activities such as driving a car, operating tools, or conversing with others. The dizziness also resolved after returning home in the evening or when rest was guaranteed.

Discussion

The AUD group presented with a higher fatigue score compared to the BPPV group; therefore, we postulate that fatigue may be related causally to dizziness. The higher fatigue score of the AUD group might result from insomnia, as indicated by our finding that fatigue severity correlated with insomnia severity. This accords with a previous report that the most common cause of fatigue was insufficient sleep, and the most common cause of insufficient sleep was determined to be too little time to sleep (Broman *et al.*, 1996). Sleep problems were reported by 65.0% of the patients with fatigue in a primary care unit (Nijrolder *et al.*, 2009). Modern lifestyle encourages later bedtimes and longer hours of nighttime arousal (Shochat, 2012). However, insomnia scores were not significantly different between the two groups in our study. One explanation may be that sleep-deprived individuals cannot identify increased sleepiness when the sleep drive is mild or moderate, or their perception of sleepiness can be masked by physical and mental conditions of high motivation, excitement, and competing needs (Hossain *et al.*, 2005). Nevertheless, fatigue can be considered a manifestation of insufficient sleep even in the absence of sleepiness (Hossain *et al.*, 2005; Lichstein *et al.*, 1997).

The difference of fatigue scores between the two groups was not due to the differences of age and symptom duration, because fatigue severity was not affected by age or symptom duration and the fatigue score was not related to age. Pollak also reported that fatigue score was inversely related to age, and was not dependent on gender and symptom duration in BPPV (Pollak and Stryjer, 2015). Meng, *et al*. reported that the relationship between age and fatigue prevalence appeared to be "J-shaped" among both men and women, with the lowest fatigue prevalence occurring in the 60 to 64 year age group for men and the 65 to 69 year age group for women (Meng *et al.*, 2010).

Several possible mechanisms may explain the co-occurrence of dizziness and fatigue in some individuals. Because postural control requires attentional cognitive processing (Horak, 2006), fatigue impacts mental functions such as attentional cognitive processing and results in disturbed postural control (Lundin-Olsson *et al.*, 1998). Another explanation is that the sense of floating, neck pain, and dizziness while rotating the neck may implicate disruption of cervical proprioceptive input leading to disturbed postural control (Karlberg *et al.*, 1996).

The DHI score showed no significant difference between the two groups. This could be explained by several factors. Although the DHI has been demonstrated to accurately discriminate between participants with and without a disability (Tamber *et al.*, 2009), it does not specifically assess intensity and type of dizziness and the presence of neurovegetative symptoms (Tufarelli *et al.*, 2007). Furthermore, it does not accurately reflect the presence or severity of underlying vestibular deficits (Yip and Strupp, 2018). Age, the presence of central vestibular system abnormalities, and the nature of the patient's principal presenting symptoms have no effect on the DHI (Pollak *et al.*, 2003).

Both groups had more than mild anxiety. The anxiety level was higher in the AUD group than in the BPPV group. It is known that many patients with organic vertigo report a sense of fear and anxiety during the vertigo attacks (Pollak *et al.*, 2003). Dysfunction of the vestibular system can trigger a psychiatric disturbance even in a previously mentally healthy person, especially in predisposed individuals (Pollak *et al.*, 2003). This notion is supported by anatomic and functional connections between the vestibular system and the limbic system being involved in the processing of emotional responses (Rajagopalan *et al.*, 2017). A possible reason for the higher level of anxiety in the AUD group relates to the association of patients' self-control against vertigo with the occurrence of anxiety (Yuan *et al.*, 2015). BPPV patients can control the severity and even avert the attack of vertigo by avoiding quick head shaking. Therefore, the anxiety level in patients with BPPV may be lower than that of their counterpart. For the patients in the AUD group, dizziness is unpredictable and uncontrollable, which may result in higher anxiety. We speculate that the anxiety in the AUP group was not the cause but rather the result of dizziness, because in this study, patients with a past history of anxiety were excluded and the included patients were thoroughly evaluated against relevant diagnostic criteria to determine whether they had a preexisting anxiety disorder.

The patients in the AUD group may have manifested the first emergence of vestibular migraine even though they did not have migraine headache in their life. The most common causes of dizziness in adult populations are vestibular migraine, underlying anxiety, or psychogenic disorders (McFeely and Bojrab, 2008; Staab *et al.*, 2004). Among patients older than 65 years, disequilibrium of aging is the major cause of dizziness (Belal and Glorig, 1986; Drachman and Hart, 1972), and among adolescents, vestibular migraine is the most common cause of dizziness (Lanzi *et al.*, 1994). No matter whether the cause of dizziness is fatigue or vestibular migraine, relieving fatigue would benefit the patients.

Our study is limited by the relative short follow-up period, the absence of sleep duration data, and the lack of analysis of the clinical characteristics of the AUD group (which was beyond the scope of this study). Further study with longer follow-up period is needed to assess whether patients with a new episode of daily dizziness would eventually be found to have vestibular migraine. Also, further study

factoring in patients' sleep duration would identify whether insomnia contributes to the pathophysiology of dizziness in fatigued individuals. Finally, statistical analysis of the clinical characteristics of the AUD group could identify potential diagnostic criteria of fatigue related dizziness as a defined clinical entity.

Conclusion

We believe that fatigue should be considered a cause of dizziness, given that the patients in the AUD group had a higher level of fatigue than those in the BPPV group, they had no other demonstrated cause of dizziness on thorough investigation, they were previously healthy, they had no prior history of dizziness, and dizziness decreased after fatigue was relieved. These findings lead us to propose the fatigue related dizziness experienced by these patients as a distinct clinical entity.

Acknowledgement

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