Association Between Vestibular Migraine and Migraine Headache: Yet to Explore

*†Mehdi Abouzari, *Khodayar Goshtasbi, *Omid Moshtaghi, *Donald Tan, *Harrison W. Lin, and *‡Hamid R. Djalilian

*Department of Otolaryngology–Head and Neck Surgery, University of California, Irvine; †Division of Pediatric Otolaryngology, Children's Hospital of Orange County, Orange; and ‡Department of Biomedical Engineering, University of California, Irvine, California

Objectives: To evaluate if patients with a diagnosis of vestibular migraine (VM) by the International Classification of Headache Disorders (ICHD) criteria have meaningful differences in symptomatology and disease characteristics when compared to patients with concurrent vestibular symptoms and migraine that do not meet ICHD criteria.

Methods: Patients who presented for the evaluation of vertigo were provided a detailed questionnaire about dizziness and migraine symptoms. Patients were assigned to either VM cohort (met ICHD criteria for VM) or migraine headache (MH) cohort (met ICHD criteria for migraine with or without aura but not VM). Disease characteristics, symptomatology, quality of life, and perceived stress score were compared between the cohorts.

Results: The VM cohort demonstrated a shorter duration of vertigo episodes, 11 ± 22 hours versus 84 ± 146 hours in the MH cohort. In the VM cohort, 81% reported experiencing migraine headaches during episodes of vertigo, versus 61% in the MH cohort. All patients in the VM cohort reported a previous diagnosis of migraine headache, whereas 9% of the MH cohort had not been previously diagnosed by another physician. There was no difference in quality of life or perceived stress scores between the cohorts.

Conclusions: A large proportion of vertigo patients with migrainous features do not meet the ICHD criteria for VM. The differences between cohorts represent selection bias rather than meaningful features unique to the cohorts. As such, VM and MH with vestibular symptoms may exist on a spectrum of the same disease process and may warrant the same treatment protocols. **Key Words:** Dizziness—ICHD criteria—Migraine headache—Vertigo—Vestibular migraine.

Otol Neurotol **41:**392–396, 2020.

Vestibular migraine (VM) is a clinical diagnosis made for certain patients who suffer from both migraine and vestibular vertigo as defined by strict criteria outlined in the International Classification of Headache Disorders (ICHD), 3rd edition (1,2). VM is the second most common cause of recurrent vertigo, and has been found to represent 6 to 7% of patients in dizziness clinics and in 9% of patients in a migraine clinic cohort (3–5). In VM, migraine is the causative factor for the patient's recurrent episodes of vertigo and its treatment is targeted toward the underlying disorder (6). Interestingly, the discovery of VM was not based on a proposed pathophysiological mechanism, but rather the statistical observation by Neuhauser et al. (7) that migraine headache and vestibular vertigo exist concurrently three times more often than would be expected by chance.

The literature has used various additional terms to describe the population of patients who experience overlapping features of both migraine headache (MH) and vestibular vertigo. These include migrainous vertigo, migraine-associated vertigo, migraine-associated dizziness, migraine-related vestibulopathy, and benign recurrent vertigo (3). However, little is known about these patients who are suspected of, but do not strictly meet the criteria for VM. Since the establishment of the ICHD criteria, there has been concern in the literature that these patients might benefit from VM treatment but may be excluded by the strict criteria. For instance, significant symptomatic improvement in dizziness has been documented with migraine treatments in these patients in a number of studies (5,8–11). However, as these studies

Address correspondence and reprint requests to Hamid R. Djalilian, M.D., Division of Neurotology and Skull Base Surgery, Department of Otolaryngology–Head and Neck Surgery, University of California Irvine, 19182 Jamboree Road, Otolaryngology-5386, Irvine, CA 92697; E-mail: hdjalili@uci.edu

M.A., K.G., and O.M. contributed equally to this work.

M.A. is supported by the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant TL1TR001415-04. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

The authors disclose no conflicts of interest.

Supplemental digital content is available in the text.

DOI: 10.1097/MAO.0000000000002528

predate the ICHD 3rd edition, a number of study participants would not meet current criteria for VM despite improvement with therapy. In this article, we aim to assess whether the application of current ICHD criteria results in a significant delineation in characteristics of patients who do or do not meet criteria for VM.

METHODS

Following Institutional Review Board approval, patients who presented with a chief complaint of at least 1 month of vertigo or disequilibrium to our tertiary care academic center's neurotology clinic from 2014 to 2018 were screened for inclusion in our study. At the initial visit, each patient was asked to complete a detailed questionnaire about their symptoms in addition to standard care. These patients were specifically evaluated for meeting the ICHD 3rd edition beta criteria for VM and migraine with or without aura, as shown in supplemental digital content 1, http://links.lww.com/MAO/A909 (1). The entire cohort included patients if they had each of the following: history of migraine headache based on the ICHD criteria, chronic or episodic vertigo lasting longer than 1 month, and a subjective description of their symptoms as a ''room spinning'' sensation. The cohort was then subdivided into a VM cohort (those who met ICHD criteria for VM) and an MH cohort (those who did not meet criteria for VM but met criteria for migraine with or without aura).

The detailed characterization of subjective migraine and vertigo symptoms such as onset, frequency, triggers, associated symptoms, etc. was compared between the two cohorts. Additionally, all subjects were queried about stress and quality of life impairment related to vertigo over the preceding 2 months. The quality of life instrument was modified from the Kato et al. Menière's disease outcomes questionnaire that consists of one global quality-of-life question as well as questions in three domains of physical, emotional, and social well-being (12). Stress was measured using the perceived stress scale, a Likert-type scale with 10 questions and scores ranging from 0 to 40 (13). Statistical analysis was performed using PASW Statistics 18.0 software (SPSS Inc., Chicago, IL) with a p value of less than 0.05 considered to be statistically significant. Due to the large number of analyzed variables and to avoid reporting of false significant results, secondary Bonferroni correction via dividing this significance threshold by the number of variables ($n = 38$) yielding a significance threshold of $p = 0.001$ was considered. Chi-square or Fisher's exact test, and independent samples t test were used to compare categorical and numerical variables between the two cohorts, respectively.

RESULTS

A total of 427 patients were screened for inclusion in the study and asked to fill out the questionnaires. Of those, 396 responders completed the surveys satisfactorily. Based on those surveys, 104 patients were assigned to the VM cohort, 100 patients were assigned to the MH cohort, and 192 patients did not meet the criteria for either cohort. The average age of all patients was 53 years (range: 14–81 yr). There was no statistically significant difference in sex or age between the VM (68% females, age 49 ± 16 yr) and MH (70% females, age 53 ± 14 yr) cohorts ($p = 0.95$ and $p = 0.28$, respectively). Most MH patients did not meet VM criteria for two primary reasons: 1) 63% of MH patients did not report at least half of their vertiginous episodes associated with migrainous features, and 2) 40% of MH patients reported vestibular symptoms did not last between 5 minutes and 72 hours (57% less than 5 min and 43% greater than 72 h). Additionally, within the MH cohort, 91 (91%) patients met the criteria for migraine with aura and only 9 (9%) patients suffered from migraine without aura.

Two features of vertigo symptomatology showed a significant difference between the VM and MH cohorts (Table 1). The VM cohort demonstrated a shorter average duration of vertigo episodes, 11 ± 22 hours versus 84 ± 146 hours in the MH cohort ($p = 0.01$). Moreover, the VM cohort contained a greater proportion of patients who reported having migraine headache concurrently with episodes of vertigo, 81% versus 61% ($p = 0.01$). As shown in Table 2, all patients in the VM cohort had a

TABLE 1. *Vertigo characteristics, symptoms, and triggers of the population cohort*

	VM (n = 104)	MH (n = 100)	p Value
Vertigo characteristics			
Years since onset of first episode	7 ± 9	6 ± 10	0.831
Age at onset of first episode	41 ± 16	48 ± 16	0.082
No. of episodes per day	1.7 ± 4	3 ± 5	0.435
Duration of episodes (hours)	11 ± 22	84 ± 146	0.010*
Concurrent migraine headache during episodes	89 (86%)	61 (61%)	0.010*
Vertigo symptoms and triggers			
Positional vertigo	91 (88%)	83 (83%)	0.680
Rotational vertigo	80 (77%)	65 (65%)	0.301
Vertigo triggered by visual motion	81 (78%)	72 (72%)	0.641
Concurrent cochlear symptoms			
Ear pressure	68 (65%)	54 (54%)	0.641
Tinnitus	71 (68%)	59 (59%)	0.435
Hearing loss	44 (42%)	37 (37%)	0.880

Table entries are mean ± standard deviation or total (percentage).

MH indicates migraine headache; VM: vestibular migraine. P values computed using independent samples t test and chi-square/Fisher's exact tests for numerical and categorical variables, respectively. Asterisk denotes a significant p value.

TABLE 2. *Migraine characteristics, symptoms, and triggers of population cohort*

	VM (n = 104)	MH (n = 100)	*p* Value
Migraine characteristics			
Years since onset of first headache	13 ± 14	16 ± 16	0.407
Age at onset of first headache	36 ± 16	36 ± 18	1.00
No. of headaches per week	4 ± 9	3 ± 6	0.761
Family history of migraine	27 (26%)	35 (35%)	0.435
Past history of migraine	104 (100%)	91 (91%)	0.010*
Past history of sinus headache	57 (55%)	66 (66%)	0.359
Symptoms associated with migraine headache			
Pulsation or throbbing pain	61 (59%)	59 (59%)	0.880
Unilateral head pain	80 (77%)	69 (69%)	0.944
Allodynia	20 (19%)	28 (28%)	0.350
Visual symptoms	42 (40%)	39 (39%)	1.00
Weakness	48 (46%)	51 (51%)	0.646
Difficulty speaking	28 (27%)	23 (23%)	0.880
Nausea	61 (59%)	50 (50%)	0.649
Light sensitivity	77 (74%)	65 (65%)	0.642
Sound sensitivity	75 (72%)	63 (63%)	0.642
Drowsiness	53 (51%)	45 (45%)	0.813
Lightheadedness	69 (66%)	54 (54%)	0.407
Migraine triggers			
Menstruation	48 (46%)	39 (39%)	0.873
Certain foods	20 (19%)	27 (27%)	0.350
Sleep disturbances	64 (62%)	51 (51%)	0.795
Physical activity	38 (37%)	33 (33%)	0.873
Bowel movements	16 (15%)	14 (14%)	1.00

Table entries are mean ± standard deviation or total (percentage).
MH indicates migraine headache; VM, vestibular migraine, *P* values computed using independent samples *t* test and chi-square/Fisher's exact tests for numerical and categorical variables, respectively. Asterisk denotes a significant *p* value.

previous diagnosis of migraine disorder, whereas only 91% of the MH cohort had been previously diagnosed ($p = 0.01$). Though significant on primary analysis, Bonferroni correction deemed these three variables nonsignificant. There was no significant difference in scores on any of the four quality of life domains or on perceived stress scale between the two cohorts (Table 3).

DISCUSSION

We found that patients who fulfill the ICHD criteria for VM are very similar in characteristics from vertigo patients with a history of migraine headache who do not fulfill the VM criteria. With few exceptions, nearly every qualitative metric used to describe the two cohorts failed to show a statistically significant difference. Even the three significant variables on primary analysis would be considered nonsignificant upon correction for potential multiple-testing error. Notably, the triggers and type of vertigo symptoms described were similarly prevalent in both cohorts. Because VM is a clinical diagnosis, the significant symptomatic overlap between MH and VM suggests etiological similarities between the two conditions. In our study, we found that adhering strictly to the ICHD criteria would miss a nearly equivalent population of patients with migraine headaches and vertigo whose

TABLE 3. *Comparison of quality of life domains and perceived stress scale scores between the two cohorts.*

	VM (n = 104)	MH (n = 100)	*p* Value
Quality of life			
Global domain	2.4 ± 1	2.9 ± 1	0.182
Mental domain	3 ± 1	3.1 ± 0.9	0.641
Physical domain	2.9 ± 0.8	2.9 ± 0.7	0.873
Social domain	3 ± 1	2.9 ± 0.6	0.171
Perceived stress scale	19 ± 8	16 ± 8	0.407

Table entries are mean ± standard deviation.
MH indicates migraine headache; VM, vestibular migraine. *P* values computed using independent samples *t* test.

vertigo might possibly respond just as well to migraine treatment.

Current ICHD criteria require that at least half of vertiginous episodes be associated with migrainous features (migraine headache, photo/phonophobia, or aura). An important finding that distinguished our cohorts was that a greater proportion of VM patients had experienced a migraine headache concurrently during episodes of vertigo. This finding is consistent with recent studies using ICHD criteria that report nearly all VM patients experience VM and migraine concurrently (14,15). However, previous studies using less strict criteria for VM have reported a lower co-occurrence of migraine and vertigo of 24 to 45% (4,7,16–18). This suggests our finding is likely a result of the classification of the disease rather than an intrinsic feature.

Thirty-nine percent of our MH cohort had not experienced vertigo and migraine headache concurrently. These patients pose a clinical challenge, as they are more likely to be excluded from a diagnosis of VM. However, it is unclear whether their underlying disease process and potential to respond to treatment are truly distinct from patients who meet criteria for VM. There is concern in the literature that these patients represent underdiagnosis of VM (5,19–21). In other words, the current ICHD criteria may be causing underdiagnosis of VM through exclusion of patients who experience vertigo and migraine headache separately. Another significant difference between our cohorts was the average duration of vertigo episodes. This indicates that the duration of symptoms was a key factor in the diagnosis and subsequent assignment to each cohort. ICHD criteria require that episodes last between 5 minutes and 72 hours. In our cohort of 100 patients with MH, 40% did not meet ICHD criteria of VM due to the duration of vertigo. This is potentially problematic as the duration criteria have changed over time and clinically may be difficult to estimate accurately (22).

In characterizing vertigo duration in VM, other authors have previously used a variety of time frames. Had we applied Neuhauser criteria instead of ICHD, 18% of our VM cohort would have experienced vertigo lasting less than 5 minutes (4). In a study by Zhang et al. that assessed VM according to ICHD, the authors chose to exclude the duration criterion when clinicians thought it was appropriate (14). These criteria are meant to exclude other etiologies of brief or long-lasting vertigo such as benign paroxysmal positional vertigo, vestibular neuritis, or labyrinthitis. Previous reports in the literature and our findings show that the duration criteria play a significant role in excluding patients from the diagnosis of VM.

Two different mechanisms of action can explain the duration of vertigo caused by migraine. Cutrer and Baloh (23) proposed that short duration vertigo spanning minutes to hours may result from the same mechanism of cortical depression observed in migraine with aura and longer lasting episodes beyond 24 hours can be caused by neuroactive peptides. Furthermore, vertigo symptoms lasting beyond 72 hours may have a similar pathophysiology to status migrainosus. In status migrainosus, patients experience a migraine headache lasting more than 72 hours (24). Those experiencing vertigo during the same time frame could also be suffering from an episode of status migrainosus manifesting as vertigo symptoms. Thus, arguments can be made that limiting a VM diagnosis to vertigo lasting within a 5-minute and 72-hour time window excludes many patients possibly suffering from VM. Furthermore, it is important to consider the reliability of patient-reported symptom duration. Patients could be experiencing true vertigo lasting between 5 minutes and 72 hours but feel unsteady for days and weeks after. This could lead patients to mistakenly state the duration of feeling ''dizzy'' or imbalanced rather than of true vertigo. This creates a challenge for clinicians as the criteria are strict and specific while their patient's report may be markedly less-so. To overcome this problem, we specifically asked patients for the duration of their vertigo episode.

In our study, only a fraction of our patients suspected of VM met ICHD criteria. When ICHD criteria are applied retrospectively to published studies describing VM, 30 to 50% of patients do not meet criteria for VM as well (4,7,25,26). In a time before 2013 when ICHD criteria did not include a diagnosis of VM, Neuhauser developed criteria that continued to evolve and be modified throughout the decade. Future updates to ICHD criteria should consider expanding the definition of VM or the formal addition of a probable VM diagnosis. These actions would have important clinical significance as patients who are underdiagnosed are also most likely undertreated.

The patient population described is a highly selective population at a tertiary academic intuition with a suspicion for VM, which represents significant selection bias. Furthermore, this study did not include a control cohort. A cohort suffering from vertigo without any migraine features would have served as a reference cohort to provide more evidence in support of the findings in our study. One statistical consideration was the presence of a large number of analyzed variables, where a significance threshold of 0.05 for analyzing 38 variables could lead to an 86% chance of at least one false significant result. As such, Bonferroni correction was discussed to control for this potential statistical error, which did not drastically change the theme of this manuscript considering its explorative nature. Future directions include larger scale prospective and randomized clinical studies of these patients' response to migraine therapy to not only further define this population but to also provide clues of the most effective means of diagnosis and treatment.

CONCLUSION

Our findings demonstrate that a large proportion of vertigo patients with migrainous features do not meet the ICHD criteria for VM. In comparing VM and MH cohorts, we found remarkable similarity in the overlap of their symptomatology. The differences between cohorts were best explained as a result of diagnostic

criteria rather than intrinsic features unique to the cohorts. As such, VM and MH may exist on a spectrum of the same disease process and therefore warrant the same treatment protocols.

REFERENCES

1. Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache Disorders, 3rd edition (beta version). *Cephalalgia* 2013;33:629–808.
2. Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache Disorders, 3rd edition. *Cephalalgia* 2018;38:1–211.
3. Neuhauser HK. The epidemiology of dizziness and vertigo. *Handb Clin Neurol* 2016;137:67–82.
4. Neuhauser H, Leopold M, Von Brevern M, Arnold G, Lempert T. The interrelations of migraine, vertigo, and migrainous vertigo. *Neurology* 2001;56:436–41.
5. Dieterich M, Brandt T. Episodic vertigo related to migraine (90 cases): Vestibular migraine? *J Neurol* 1999;246:883–92.
6. Neuhauser H, Lempert T. Vestibular migraine. *Neurol Clin* 2009;27:379–91.
7. Neuhauser HK, Radtke A, Von Brevern M, et al. Migrainous vertigo: Prevalence and impact on quality of life. *Neurology* 2006;67:1028–33.
8. Bikhazi P, Jackson C, Ruckenstein MJ. Efficacy of antimigrainous therapy in the treatment of migraine-associated dizziness. *Am J Otol* 1997;18:350–4.
9. Johnson GD. Medical management of migraine-related dizziness and vertigo. *Laryngoscope* 1998;108:1–28.
10. Waterston J. Chronic migrainous vertigo. *J Clin Neurosci* 2004;11:384–8.
11. Whitney SL, Wrisley DM, Brown KE, Furman JM. Physical therapy for migraine-related vestibulopathy and vestibular dysfunction with history of migraine. *Laryngoscope* 2000;110:1528–34.
12. Kato BM, LaRouere MJ, Bojrab DI, Michaelides EM. Evaluating quality of life after endolymphatic sac surgery: The Ménière's Disease Outcomes Questionnaire. *Otol Neurotol* 2004;25:339–44.
13. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;24:385–96.
14. Zhang Y, Kong Q, Chen J, Li L, Wang D, Zhou J. International Classification of Headache Disorders 3rd edition beta-based field testing of vestibular migraine in China: Demographic, clinical characteristics, audiometric findings and diagnosis statues. *Cephalalgia* 2016;36:240–8.
15. Cho SJ, Kim BK, Kim BS, et al. Vestibular migraine in multicenter neurology clinics according to the appendix criteria in the third beta edition of the International Classification of Headache Disorders. *Cephalalgia* 2016;36:454–62.
16. Kayan A, Hood JD. Neuro-otological manifestations of migraine. *Brain* 1984;107:1123–42.
17. Von Brevern M, Radtke A, Clarke AH, Lempert T. Migrainous vertigo presenting as episodic positional vertigo. *Neurology* 2004;62:469–72.
18. Vuković V, Plavec D, Galinović I, Lovrenčić-Huzjan A, Budišić M, Demarin V. Prevalence of vertigo, dizziness, and migrainous vertigo in patients with migraine. *Headache* 2007;47:1427–35.
19. Brandt T, Dieterich M. The vestibular cortex: Its locations, functions, and disorders. *Ann N Y Acad Sci* 1999;871:293–312.
20. Brandt T, Strupp M. Migraine and vertigo: Classification, clinical features and special treatment considerations. *Headache Curr* 2006;3:12–9.
21. Brandt T, Dieterich M, Strupp M. *Vertigo and Dizziness*, 2nd ed. London, UK: Springer-Verlag; 2013.
22. Lempert T, Olesen J, Furman J, et al. Vestibular migraine: Diagnostic criteria. *J Vestib Res* 2012;22:167–72.
23. Cutrer FM, Baloh RW. Migraine associated dizziness. *Headache* 1992;32:300–4.
24. Solomon S. Migraine diagnosis and clinical symptomatology. *Headache* 1994;34:S8–12.
25. Radtke A, Neuhauser H, Von Brevern M, Hottenrott T, Lempert T. Vestibular migraine-validity of clinical diagnostic criteria. *Cephalalgia* 2011;31:906–13.
26. Radtke A, Von Brevern M, Neuhauser H, Hottenrott T, Lempert T. Vestibular migraine; Long-term follow-up of clinical symptoms and vestibulo-cochlear findings. *Neurology* 2012;79:1607–14.