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Migraine Features in Patients With Isolated Aural Fullness and Proposal for a New Diagnosis

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Objective: To compare the presence of migraine features between patients with isolated aural fullness (AF) who meet the diagnostic criteria for migraine headache and those who do not, and to propose diagnostic criteria for migraine-related AF based on our results.

Methods: We performed a retrospective study of patients presenting to a tertiary-care neurotology clinic between 2014 and 2020 with migraine-related AF. This was defined as isolated, prolonged aural fullness concurrent with migraine features once other etiologies were ruled out via examination, audiometry, and imaging. Migraine features were compared between patients meeting the diagnostic criteria for migraine headache and those not meeting the criteria.

Results: Seventy-seven patients with migraine-related AF were included. The mean age was 56 ± 15 years and 55 (71%) patients were female. Eleven (14%) patients fulfilled the criteria for migraine headache (migraine group). Of the 66 patients who did not meet the criteria (nonmigraine group), 17 (26%) met 4/5 criteria, and 32 (48%) met 3/5 criteria, for a total of 49 (74%) patients. The migraine and nonmigraine groups were only different in 5 of 20 features, including family history of migraine ($p = 0.007$), sound sensitivity ($p < 0.001$), mental fogginess ($p = 0.008$), visual motion sensitivity ($p = 0.008$), and light sensitivity ($p < 0.001$).

Conclusion: There are minimal differences in the overall prevalence of migraine features between patients with migraine-related AF who meet and do not meet the diagnostic criteria for migraine. Our findings suggest that the criteria may be too stringent and exclude many patients from potentially benefitting from treatment with migraine prophylaxis. **Key Words:** Aural fullness—Ear pressure—Migraine headache—Otologic migraine.

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Aural fullness (AF) is a broadly defined otologic complaint, often described as ear fullness or a clogging sensation that can cause considerable discomfort (1). The most frequently identifiable causes of AF include Eustachian tube dysfunction and otitis media. However, it has also been reported as a common symptom in patients with temporomandibular joint disorder, sudden sensorineural hearing loss, Menière's disease, and third window syndrome (e.g., canal dehiscence, perilymphatic fistula) (2–6). In the context of migraine, AF has been previously studied in its association with vestibular migraine (VM), with reports showing a prevalence ranging from 19 to 51% in VM patients as well as improvement in AF symptoms with VM treatment (7–12). In our experience, a subset of patients with migraine features have reported AF, but do not suffer from concurrent vertiginous episodes necessary to fulfill a diagnosis of VM. Given the otherwise normal examination of these patients, the presence of AF seems to suggest an alternative etiology.

The clinical entity of isolated, prolonged AF has been only recently described as a potential symptom of migraine disorder. In a study by Moshtaghi et al. (13), 11 patients with isolated, prolonged AF were found to have a high prevalence of migraine features and experienced symptom and quality of life improvement after treatment with migraine diet and lifestyle modifications and migraine medications. These findings therefore signal a possible link between migraine headache and isolated AF. Many patients who present to our clinic are thought to suffer from migraine-related AF based on

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the same study criteria used by Moshtaghi et al. and response to migraine therapy. Additionally, a minority of these patients concurrently suffer from migraine headache as defined by the International Classification of Headache Disorders 3rd edition (ICHD-3) criteria (14). However, the majority who do not fulfill the diagnostic criteria nonetheless frequently present with migraine features and report improvement after treatment with migraine therapy. The objective of our study was 1) to compare the prevalence of migraine features in a larger cohort of patients with migraine-related AF who either meet or do not meet the ICHD-3 guidelines for migraine headache and 2) to propose a set of criteria for the diagnosis of migraine-related AF based on our findings.

METHODS

Following Institutional Review Board approval, we performed a retrospective chart review of all adult (age $\geq$ 18 yrs) patients with complete data who were determined to have migraine-related AF at our tertiary-care neurotology clinic from 2014 to 2020. At the initial visit, each patient was instructed to complete a custom-designed, 28-item questionnaire used to identify their migraine-related symptoms and evaluate the presence of migraine. Survey responses were retrospectively analyzed to determine which patients met the ICHD-3 migraine criteria (Table 1). Migraine-related AF (isolated, prolonged AF with concurrent migraine features) was diagnosed according to the inclusion criteria set by Moshtaghi et al. in their original study: 1) persistent AF $\geq$ 6 months; 2) normal physical examination, no conductive or low-frequency sensorineural hearing loss, and normal tympanogram; 3) lack of improvement with manual nasal Valsalva or myringotomy; and 4) negative findings on either computed tomography scan or magnetic resonance imaging to rule out canal dehiscence or tumor. If the magnetic resonance imaging did not rule out canal dehiscence due to a close semicircular canal to the dura, a computed tomography scan of temporal bones with 0.6 mm cuts was obtained to rule out a third window syndrome. Additionally, patients who fulfilled the criteria for Menière's disease (according to the American Academy of Otolaryngology—Head and Neck Surgery) or VM (according to the International Headache Society), or those who reported autophony, were grouped separately (13–15). Patients who were initially thought to suffer from Eustachian tube dysfunction were included if they failed a trial of daily autoinsufflation, antihistamines, reflux medications, or intranasal corticosteroids, and no improvement with myringotomy. The entire cohort was then divided into patients who fulfilled the ICHD-3 criteria for migraine headache (migraine group) and patients not meeting the full ICHD-3 criteria (nonmigraine group). Statistical analysis was performed using SPSS 26.0 (SPSS Inc., IBM Company, Chicago, IL). A p value < 0.01 was considered to be statistically significant, due to multiple comparisons. Chi-square or Fisher's exact test were used to compare categorical variables between the cohorts.

TABLE 1. *Diagnostic criteria for migraine headache without aura as defined by the International Classification of Headache Disorders, 3rd edition (ICHD-3) (14)*

Migraine headache without aura
A. At least five attacks fulfilling criteria B to D
B. Headache attacks lasting 4 to 72 hours (untreated or unsuccessfully treated)
C. Headache has at least two of the following four characteristics:
1. unilateral location
2. pulsating quality
3. moderate or severe pain intensity
4. aggravation by or causing avoidance of routine physical activity (e.g., walking or climbing stairs)
D. During headache at least one of the following:
1. nausea and/or vomiting
2. photophobia and phonophobia
E. Not better accounted for by another ICHD-3 diagnosis.

ICHD-3 indicates International Classification of Headache Disorders, 3rd edition.

RESULTS

A total of 77 patients were included. The mean age of all patients was 56.2 years (range, 20–83 yrs). Fifty-five (71%) patients were female and 22 (29%) were male. The mean onset of AF symptoms before the initial clinic visit was 25.2 ± 30.5 months (range, 0–144 mo). Nineteen (25%) patients had a history of headache. Seven (9%) patients had a family history of migraine. Eleven (14%) patients fulfilled the ICHD-3 criteria for migraine headache (migraine group). Of the 66 patients who did not meet the full criteria (nonmigraine group), 17 (26%) met 4 of 5 migraine criteria, and 32 (48%) met 3 of 5 criteria, for a total of 49 (74%) patients (Fig. 1). In patients who met 4/5 criteria, 8 patients had experienced 4 headache attacks (of the required 5 attacks necessary to diagnose migraine) at the time of the survey. The migraine and nonmigraine groups were only different in 5 of 20 total migraine features examined, including family history of migraine ($p = 0.007$), sound sensitivity ($p < 0.001$), mental fogginess ($p = 0.008$), visual motion sensitivity ($p = 0.008$), and light sensitivity ($p < 0.001$). Table 2 summarizes the prevalence of individual migraine features in patients who met the ICHD-3 migraine headache criteria and those who did not meet the full criteria.

DISCUSSION

Our study is the first to compare the prevalence of migraine features between patients with migraine-related AF who meet the ICHD-3 criteria for migraine and those who do not meet the diagnostic criteria. In our cohort, 14% of patients met the migraine criteria, but of the 20 migraine features examined, only 5 features were significantly more prevalent in the migraine cohort. It is also important to note that of the 17 patients who met 4/5 migraine criteria, nearly half (8/17) were only missing 1 additional migraine episode necessary to make a migraine diagnosis. Although these patients may not have fulfilled the migraine criteria at the time of their initial survey, this does not preclude the presence of migraine as these patients may eventually experience a subsequent attack and thus meet criteria at a later time point. Combined with the results from the original study by Moshtaghi et al., our findings suggest that the current

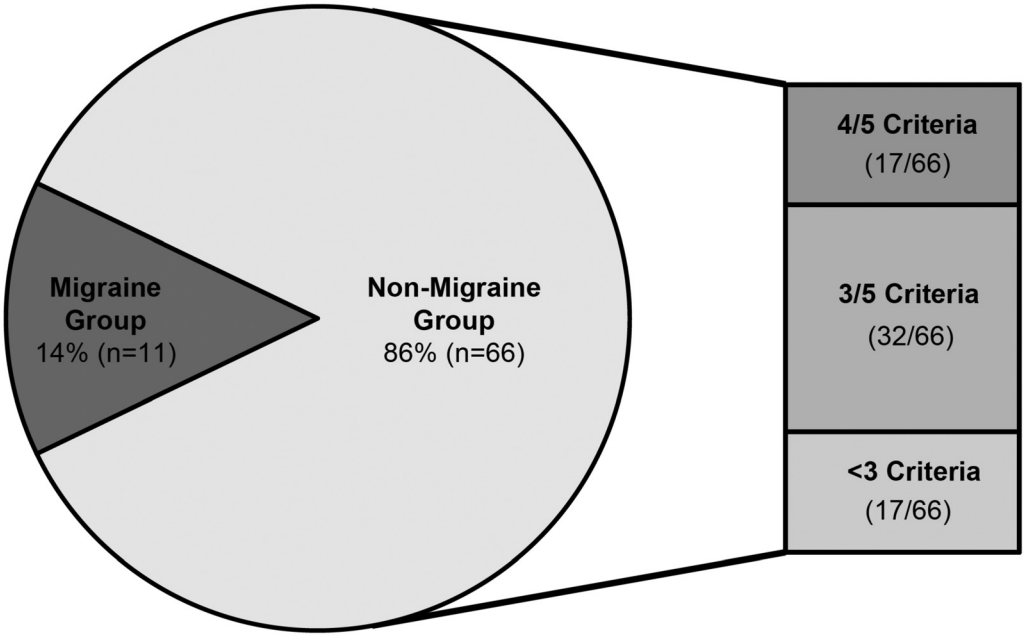

FIG. 1. Percentage of patients with aural fullness who met ICHD-3 criteria for migraine headache (migraine group). ICHD-3 indicates International Classification of Headache Disorders, 3rd edition.

migraine criteria might be too stringent, and unfortunately exclude many patients with migraine-related AF from receiving and possibly benefitting from migraine treatment. We think that expansion of ICHD-3 criteria to include aural fullness would result in a larger pool of patients receiving treatment. Based on our results, we propose the following diagnostic criteria for migraine-related AF: (A) aural fullness with a normal otologic

TABLE 2. *Migraine features in patients meeting ICHD-3 criteria for migraine (migraine group) versus patients not meeting ICHD-3 criteria for migraine (nonmigraine group)*

Migraine Feature	Nonmigraine (n = 66) No. (%)	Migraine (n = 11) No. (%)	*p* Value
History of migraine headaches	13 (19.7)	6 (54.5)	0.22
Family history of migraine headaches	3 (4.5)	4 (36.4)	0.007[a]
Unilateral head pain	4 (6.1)	2 (18.2)	0.202
Allodynia	3 (4.5)	0 (0.0)	1.000
Visual symptoms	2 (3.0)	2 (18.2)	0.095
Difficulty speaking	0 (0.0)	1 (9.1)	0.143
Nausea	1 (1.5)	2 (18.2)	0.052
Sound sensitivity	2 (3.0)	5 (45.5)	<0.001[a]
Symptoms exacerbated by			
Menstruation	0 (0.0)	1 (9.1)	0.143
Certain foods	1 (1.5)	0 (0.0)	1.000
Physical activity	4 (6.1)	1 (9.1)	0.548
Mental fog	1 (1.5)	3 (27.3)	0.008[a]
Visual motion sensitivity	1 (1.5)	3 (27.3)	0.008[a]
Head motion sensitivity	1 (1.5)	2 (18.2)	0.052
Sinus pain, facial pressure, or headache when exposed to wind or air conditioning	2 (3.0)	0 (0.0)	1.000
Light sensitivity	0 (0.0)	5 (45.5)	<0.001[a]
Motion sickness	8 (12.1)	4 (36.4)	0.063
Neck stiffness	4 (6.1)	1 (9.1)	0.548
History of chronic sinus headaches	1 (1.5)	0 (0.0)	1.000

[a]Denotes statistically significant values (alpha = 0.01).
ICHD-3 indicates International Classification of Headache Disorders, 3rd edition.

TABLE 3. *Proposed diagnostic criteria for migraine-related aural fullness*

Migraine-related aural fullness
Major features
A. Aural fullness with normal otologic examination, tympanometry, and audiometry, not meeting the criteria for other disease processes with negative imaging.
Minor features
B. At least one of the following migraine characteristics:
1. Personal or family history of migraine headaches
2. Chronic headaches or unilateral neck stiffness
3. Sound sensitivity, visual or head motion sensitivity, or light sensitivity

examination, tympanometry, and audiometry, not meeting the criteria for other disease processes with negative imaging (major features); and (B) at least one of the following 1) to 3): 1) personal or family history of migraine headaches, 2) chronic headaches or unilateral neck stiffness, 3) sound sensitivity, visual or head motion sensitivity, or light sensitivity (minor features) (Table 3).

The pathophysiology of migraine is complex and remains poorly understood. However, several studies investigating the potential underlying mechanisms may serve to explain the presence of otologic symptoms linked to migraine. One prevailing hypothesis of migraine pathophysiology is cortical spreading depression, in which a wave of depolarization causes release of neuropeptides from the trigeminal nerve leading to migraine aura and pain, as well as auditory and balance symptoms (16–18). Trigeminal nerve fibers have been shown to innervate the spiral modiolar artery and stria vascularis, important structures within the cochlear vascular network (19). It has been theorized that trigeminal innervation therefore serves as the link between migraine and concurrent cochleovestibular symptoms including tinnitus, vertigo, and hearing loss (19). Experiments conducted in animal models have demonstrated the presence of plasma extravasation in the cochlea due to alterations in vascular permeability after trigeminal nerve stimulation (20). This phenomenon is thought to contribute to the otologic manifestations of migraine, and we theorize that these central processes may also contribute to migraine-related AF.

It has been previously hypothesized that AF may originate specifically from a somatotopic relationship between the tympanic membrane and trigeminal nerve (21). This link is evidenced by studies demonstrating sensory innervation of the tympanic membrane by the trigeminal nerve fibers and also through rodent anatomic studies showing divisions of the trigeminal ganglion projecting into the cochlear nucleus and superior olivary complex (22,23). Another major theory regarding the presence of aural fullness with headache and migraine symptoms involves the tonic tensor tympani syndrome, which was first described by Klockhoff in the early 1970s (24). In tonic tensor tympani syndrome, there is a decrease in the contraction threshold of the tensor tympani muscle, which results in symptoms of chronic ear pain, headache, and aural fullness in the affected ear. These patients have been described to have tinnitus and hyperacusis as well. The trigeminal nerve is thought to play a significant role in this syndrome, as contractions of the tensor tympani muscle are elicited to a greater degree by trigeminal nerve stimuli compared with acoustic stimuli (25). While the exact mechanisms of isolated aural fullness remain to be elucidated, we think that the trigeminal nerve serves as a critical link between this symptom and migraine.

The results of the present study add further support to the hypothesis that prolonged aural fullness represents a symptom of ''otologic migraine,'' a term recently introduced to the literature to characterize a spectrum of disorders in which migraine manifests primarily with cochleovestibular complaints (26–31). We think that proper identification and treatment of these otologic symptoms with migraine therapies may avoid unnecessary surgical interventions and excess diagnostic work-up. For example, we have seen a number of patients with migraine-related aural pressure/fullness undergo Eustachian tube balloon dilation procedures, which did not improve their symptoms. Many of these patients were later successfully treated at our institution as ''probable migraine without aura'' after meeting our proposed criteria for migraine-related AF and were offered migraine lifestyle/diet optimization, and if necessary, migraine prophylactic medication.

This study has certain limitations as a retrospective review, including the accuracy and availability of patient information, and selection bias with respect to patients determined to have migraine-related AF by the neurotologists at our institution. Additionally, the survey-based nature of our data introduces the possibility of recall bias, which may influence statistical outcomes and warrant cautious interpretation of the study results. As there is currently no objective diagnostic test for migraine-related AF, the number of false positives cannot be accurately determined, and it is possible that other etiologies of aural fullness may have been missed. Future prospective studies should examine larger cohorts of patients presenting with migraine-related AF to further define the clinical features that may guide treatment and response to migraine therapy.

CONCLUSION

This study reveals minimal meaningful differences in migraine features between patients in our cohort with migraine-related AF who meet the ICHD-3 migraine headache criteria and those who do not. Our findings further support the association between isolated, prolonged aural fullness and migraine, and suggest that the current diagnostic criteria for migraine may unnecessarily exclude many patients from receiving beneficial migraine treatment.

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