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Migrainous Vertigo, Tinnitus, and Ear Symptoms and Alternatives



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KEYWORDS

• Tinnitus • Vertigo • Dizziness • Hearing loss • Alternative medicine

KEY POINTS

- Migraine is a chronic disorder that frequently coexists with vestibular and neuro-otological symptoms leading to significant physical and psychological disabilities including tinnitus and hearing loss.
- The evidence currently encourages the use of cognitive behavioral therapy and supplements for the treatment of tinnitus and vestibular rehabilitation for vertigo.
- Based on the review results, complementary and integrative medicine should undergo further high-quality clinical trials to obtain more definitive data to translate these therapies into routine recommendations for patients.

INTRODUCTION

Migraine headaches frequently coexist with vestibular symptoms such as vertigo, motion sickness, and gait instability. Migraine-related vasospasm can also damage the inner ear, which results in symptoms such as sudden sensorineural hearing loss (SSNHL) and tinnitus.¹ The pathophysiology of these symptoms is not yet fully understood, and despite their prevalence, there is no universally approved management.

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Owing to patient belief, nonuniversal effectiveness, cost, and fear of the side effects of conventional treatments, many patients with migraine-related symptoms seek complementary and integrative medicine (CIM) alternatives. Traditional medicine (acupuncture, herbal supplements, and manual therapies) originated in China about 3000 years ago and then spread to Korea and Japan with Buddhism.² However, some in the United States still regard CIM therapies with skepticism mainly because of the lack of randomized clinical trials.^{3,4} A cross-sectional study conducted between 2002 and 2012 reported that 33.2% of adults in the United States use complementary health approaches (dietary supplements, deep breathing exercises, and yoga),⁵ with 75% of patients not informing their physician about this practice.³ This review summarizes the data on CIM in treating patients with migrainous ear disorders ([Tables 1–3](#)).

COGNITIVE BEHAVIORAL THERAPY

Cognitive behavioral therapy (CBT) is an active approach that includes a wide array of strategic interventions such as cognitive restructuring, behavioral activation, exposure, and problem solving. CBT helps reduce emotional distress and increase adaptive behaviors, thus adopting a problem-solving strategy.⁶ Several studies evaluating CBT for tinnitus have demonstrated its effectiveness as an alternative approach.^{7–9}

In a randomized double-blind controlled study,¹⁰ patients with tinnitus were allocated in 2 groups: the first one receiving CBT with sound-focused tinnitus retraining therapy and the second group was provided standard audiological intervention. Patients assigned to CBT showed a decrease in tinnitus severity and improvement in their quality of life (QOL). In another study, Beukes and colleagues¹¹ concluded that Internet-delivered CBT (iCBT) helped reduce tinnitus distress and associated difficulties (anxiety, depression, and insomnia), hence improving the QOL. Andersson¹² reported that iCBT is as effective as face-to-face CBT. Furthermore, a smartphone-based iCBT and customized sound therapy were found to be effective in treating tinnitus.⁷ Although in this study no significant improvement was reported in the Generalized Anxiety Disorder 7-item and Perceived Stress Scale, a significant reduction of Tinnitus Handicap Index (THI), which measures tinnitus-related stress, anxiety, and QOL, was observed in the treatment group.⁷ In addition, in a Cochrane systematic review, including 28 studies comparing CBT versus no intervention, audiological care, tinnitus retraining therapy, or any other active control, the investigators concluded that CBT may be effective in reducing tinnitus negative impact on QOL and associated depression.¹³ In line with the previous results, Nolan and colleagues¹⁴ showed a highly significant reduction in tinnitus, hyperacusis, and concomitant psychological symptoms posttreatment with CBT. Based on the data, CBT is a valuable treatment option for the treatment of tinnitus.

YOGA

There are several studies demonstrating the benefits of yoga in patients with tinnitus.^{15–17} The first study by Köksoy and colleagues¹⁵ showed that yoga practices reduce tinnitus severity and tinnitus stress score. Thus, practicing yoga improves the symptoms of tinnitus and QOL, and reduces stress and anxiety.¹⁵ Another study in 25 patients with chronic tinnitus assessed 12 weeks of yoga training compared with a control group of 13 patients. The yoga group improved on the tinnitus functional index (TFI) global score.¹⁶ Both studies were limited by the lack of longer-term follow-up and small sample sizes. Gazbare and colleagues¹⁷ performed a randomized controlled trial comparing the effect of yogasanas (yoga postures) with gaze stabilization and

Table 1
Summary of alternative treatments of tinnitus

Symptom	Alternative Medicine Interventions	Study	Study Nature	Sample Size	Key Findings
Tinnitus	CBT	Abouzari et al, ⁷ 2021	Randomized controlled trial	30 Patients	Treatment group: significant higher improvement in THI scores after smartphone-based iCBT and sound therapy
		McKenna et al, ⁹ 2020	Meta-analysis		CBT is an effective treatment of tinnitus distress
		Cima et al, ¹⁰ 2012	Randomized controlled trial	492 Patients	CBT group: a significant improvement in QOL, decrease in tinnitus severity, and tinnitus impairment
		Beukes et al, ¹¹ 2019	Meta-analysis	15 Studies	Tinnitus: significant favor of tinnitus iCBT over inactive and active controls Hearing loss: no significant favor for either intervention. Study quality affected the outcome
	Yoga	Andersson, ¹² 2015	Systemic review	9 Controlled studies	iCBT is more effective than no-treatment condition
		Fuller et al, ¹³ 2020	Meta-analysis	28 Controlled studies	iCBT is as effective as face-to-face CBT In all CBT groups, primary outcome: significant reduction of the impact of tinnitus on QOL
		Nolan et al, ¹⁴ 2020	Cross-sectional	268 Patients	CBT vs no intervention: 14 studies. CBT vs audiological care: 3 studies. Secondary outcome: reduction is depression
		Köksoy et al, ¹⁵ 2018	Clinical trial	12 Patients	CBT vs TRT: 1 study. No secondary outcome
	Neurofeedback	Niedzialek et al, ¹⁶ 2019	Randomized controlled trial	38 Patients	CBT vs active control (relaxation, information, Internet-based discussion forums): 16 studies. Secondary outcome: reduction in depression and anxiety
		Peter et al, ¹⁸ 2019	Review		Reduction of TQ, QHS, BSI, and BDI-II
		Guillard et al, ¹⁹ 2021	Clinical trial	33 Patients	Yoga practices reduce stress, handicap, and severity of tinnitus
		Güntensperger et al, ²² 2020	Randomized controlled trial	26 Patients	Significant decrease in 5 of 8 subscales of TFI global score (intrusiveness, sense of control, sleep, auditory, and quality of life)
					TMS: to be used for tinnitus localization rather than tinnitus suppression. tDCS, transcranial random noise stimulation: qualify as a promising method in tinnitus treatment
					Neurofeedback: should be further investigated as a treatment modality for tinnitus Vagus nerve stimulation: promising treatment option for tinnitus Invasive brain stimulation: more research is needed. It will always be limited to a very select group because it is invasive

(continued on next page)

Table 1
(continued)

Symptom	Alternative Medicine Interventions	Study	Study Nature	Sample Size	Key Findings
Hypnosis		Güntensperger et al, ²¹ 2019	Randomized controlled trial	48 Patients	Significant reduction of tinnitus loudness and related distress in both groups Significant increase in trained alpha/delta ratio over the course of training and follow-up period
		Emmert et al, ²³ 2017	Randomized controlled trial	14 Patients	Significant deactivation of the secondary auditory cortex until the last session for the continuous group vs intermittent feedback showed the strongest downregulation in the first session
	Hypnosis	Ross et al, ²⁶ 2007	Controlled clinical trial	393 Patients	Decrease of the TFI scores that was not statistically significant
		Maudoux et al, ²⁷ 2007	Clinical trial	49 Patients	Significant improvement of the TQ and SF-36 scores when compared with the waiting-list controls
		Yazıcı et al, ²⁸ 2012	Controlled clinical trial	39 Patients	Significant improvement of the THI and SF-36 scores
		Brüggemann et al, ³⁶ 2021	Meta-analysis	3 Placebo-controlled clinical trials	Significant reduction in tinnitus severity
		Spiegel et al, ³⁷ 2018	Review	5 Placebo-controlled clinical trials	Significant improvement of anxiety, depression, and cognition
		Radunz et al, ³⁸ 2020	Randomized controlled trial	33 Patients	EGb761 significantly superior to placebo in alleviating tinnitus and dizziness
					Significant improvement of the THI score with the individual HA and/or GB EGB71
					HA were more effective in patients with shorter time to onset of tinnitus
					GB alone or in association with HA was effective regardless of tinnitus duration
					After adjustment of sex, age and hearing loss, no significant difference in zinc levels between a tinnitus population and a control population
Zinc	Zinc	Jun et al, ⁴⁷ 2015	Case-control	2225 Patients	Significant lower zinc levels in the most severe tinnitus group compared with the control group
		Berkiten et al, ⁴⁸ 2015	Cross-sectional	100 Patients	Patients in group III (between 61 and 78 years old) have significantly lower serum zinc levels
		Coelho et al, ⁴⁹ 2013	Randomized controlled trial	116 patients	Significantly higher hearing thresholds of air conduction in zinc-deficient patients
		Person et al, ⁵⁰ 2016	Systemic review	3 Randomized controlled trials	Significantly higher Tinnitus Severity Index Questionnaire and loudness scores in zinc-deficient patients
		Lee and Kim, ⁵⁸ 2018	Cross-sectional	1435 Patients	No significant improvement in THQ scores after zinc treatment or placebo
Vitamin B and antioxidants	Vitamin B and antioxidants				Overall, no significant improvement in tinnitus severity and loudness. No significant improvement in any secondary outcome (QOL, anxiety, and depression)
					Less intake of vitamin B ₂ is associated with tinnitus in middle-aged patients. Less intake of water, protein, and vitamin B ₃ is associated with tinnitus-related annoyance in elderly. It is recommended to use vitamin B ₂ and B ₃ in combination with pharmacologic or behavioral therapy
		Singh et al, ⁵⁹ 2016	Randomized Controlled Trial	40 Patients	Significant improvement in mean TSI score and VAS after vitamin B ₁₂ treatment in patients with tinnitus and cobalamin deficiency

Melatonin	Hameed et al, ⁶⁰ 2018	Observational Cohort	75 Patients	Supplementation with vitamin B complex improves the tinnitus severity, specifically in patients with tinnitus and without hearing loss DPOAE changing amplitude can be used as a tool to assess the effect of vitamin B complex used in patient with tinnitus with or without hearing loss
	Dawes et al, ⁶¹ 2020	Cross-sectional	34,576 Patients	Higher intake of vitamin B ₁₂ and protein is associated with reduced odds of tinnitus. Meanwhile, a high intake of calcium, iron, and fat were associated with increased odds of tinnitus High intake of vitamin D, fruits and vegetables, and protein is associated with reduced likelihood of hearing difficulties. High fat intake was associated with hearing difficulties
	Ekinci et al, ⁶² 2020	Randomized Controlled Trial	50 patients	Serum prolidase enzyme and oxidative stress might participate to the etiopathogenesis of tinnitus
	Khan et al, ⁶³ 2007	Clinical Trial	20 patients	CoQ10 supply in patients with low CoQ10 levels may decrease tinnitus
	Albu and Chirtes, ⁶⁶ 2014	Randomized Controlled Trial	60 Patients	In the intratympanic dexamethasone plus melatonin (compared with melatonin alone): significant improvement in all of the following outcome measures: tinnitus loudness score, tinnitus awareness score, THI, PSQI, and BDI
	Rosenberg et al, ⁶⁸ 1998	Randomized Controlled Trial	30 Patients	Statistically significant overall improvement among patients with high THI scores and/or difficulty sleeping taking melatonin when compared with placebo
	Abtahi et al, ⁶⁹ 2017	Randomized Controlled Trial	70 Patients	THI scores were significantly reduced in the melatonin and sertraline groups, but the use of melatonin is more effective
	Miroddi et al, ⁷⁰ 2015	Review	5 Clinical Studies	The authors were not able to confirm the effectiveness of melatonin in treating tinnitus; however, melatonin improved sleep disturbances associated with tinnitus
	Merrick et al, ⁷¹ 2014	Review		Patient with tinnitus can benefit from melatonin through its antioxidant and sleep enhancement properties
	Tu et al, ⁷² 2019	Randomized Controlled Trial	30 Patients	Significant reduction in THI in DA group greater than that in SA group DA can modulate the autonomic nervous system by activating the sympathetic and parasympathetic nervous system balance
Acupuncture	Cai et al, ⁷³ 2019	Clinical Trial	54 Patients	Significant reduction in temperature differentials of both sides after acupuncture implying an even distribution of blood in both cochlea
	Naderinabi et al, ⁷⁴ 2018	Randomized Controlled Trial	88 Patients	TSI and VAS significantly improved in all groups; however, the differences by both measures were better with acupuncture compared with placebo at the end of the late sessions
	Pang et al, ⁷⁵ 2019	Review	40 Randomized Controlled Trials	The 8 different methods of acupuncture are effective in treating tinnitus. The clinical effect from high to low is as follows: moxibustion acupuncture, moxibustion acupuncture combined with electroacupuncture, moxibustion acupuncture combined with supplementary medication, traditional acupuncture combined with supplementary medication, electroacupuncture combined with supplementary medication, electroacupuncture, traditional acupuncture, and medication-only treatment

Abbreviations: BDI-II, Beck Depression Inventory; BSI, Brief Symptom Inventory; CBT, cognitive behavioral therapy; DA, deep acupuncture; DPOAE, distortion product otoacoustic emissions; EH, Ericksonian hypnosis; GB, *Ginkgo biloba*; HA, hearing aid; iCBT, Internet-based CBT; PSQI, Pittsburgh Sleep Quality Index; SA, shallow acupuncture; SF-36, 36-Item Short Form Health Survey; tDCS, transcranial direct current stimulation; TFI, Tinnitus Functional Index; THI, Tinnitus Handicap Inventory; THQ, Tinnitus Handicap Questionnaire; TMS, transcranial magnetic stimulation; TQ, Tinnitus Questionnaire; TRT, tinnitus retraining therapy; TSI, Tinnitus Severity Index; QHS, Questionnaire on Hypersensitivity to Sound; QOL, Quality Of Life; VAS, visual analog scale.

Table 2
Summary of alternative treatments of vertigo/dizziness

Symptom	Alternative Medicine Interventions	Study	Study Nature	Sample Size	Key Findings
Vertigo	Yoga	Gazbare et al, ¹⁷ 2021	Randomized controlled trial	32 Patients	Both groups reduced symptoms of dizziness Yogasanas: better improvement in MSQ Gaze stabilization and habituation exercises: better improvement in DHI
		Brown et al, ²⁹ 2006	Case-series	48 Patients	Statistically significant improvement after physical therapy on the ABC, DHI, DGI, the timed up & go test, and the FTSTS test
	Physical therapy	Whitney et al, ³⁰ 2000	Case series	39 Patients	Statistically significant improvement after physical therapy on the DHI, ABC, PDS, the DGI, and the CS
		Brown et al, ³¹ 2001	Case series	24 Patients	Statistically significant improvement after physical therapy on the DHI, ABC, DGI, timed up & go measures, and the CS scores
		Regauer et al, ³² 2020	Systematic review	20 Randomized and 2 nonrandomized controlled trials	Interventions included: VR, CAVR, TCVR, CRM, and MT. VR and VR in addition to CRM and MT are effective in treating patients with VDB
	<i>Ginkgo biloba</i>	Liu et al, ³³ 2020	Clinical trial	19 Patients	Significant decrease of the DHI and HAMA scores Significant increase of the ALFF values in the left posterior cerebellum
		Sokolova et al, ⁴² 2014	Randomized controlled trial	160 Patients	Both drugs were similarly effective in the treatment of vertigo, but EGb761 was better tolerated
		Hamann et al, ⁴³ 2006	Systematic review		Preclinical and double-blind clinical studies show that EGb761 promotes compensation and is effective in the treatment of vertigo syndromes
		Lindner et al, ⁴⁴ 2019	Preclinical study	40 Rats	Group A: significant reduction of nystagmus scores, of postural asymmetry, and increased motility in the open field when compared with controls Groups B and C: fast recovery of postural asymmetry

<i>Ginkgo biloba</i> in combination with neurofeedback	Decker et al, ⁴⁵ 2021	Randomized controlled trial	120 Patients	Statistically significant improvement in the fall risk in balance-related situations and proprioceptive components of the gSBDT-CS in the active group
Zinc	Ferreira et al, ⁵¹ 2009	Case-control	16 Patients	Hypozincemia affects the function of the vestibulo-ocular, vestibulocerebellar, and vestibulocortical pathways
Acupuncture	Chiu et al, ⁷⁸ 2015	Randomized controlled trial	60 Patients	Acupuncture reduced discomfort and VAS of both vertigo and dizziness after 30 min treatment in the emergency department

Abbreviations: ABC, Activities-Specific Balance Confidence Scale; ALFF, amplitude of low-frequency fluctuations; CAVR, computer-assisted vestibular rehabilitation; CRM, canalith repositioning maneuvers; CS, Composite Score; DGI, Dynamic Gait Index; DHI, Dizziness Handicap Inventory; FTSTS, Five Times Sit-to-Stand; gSBDT-CS, Geriatric Standard Balance Deficit Test Composite Score; HAMA, Hamilton Anxiety Scale; MSQ, Motion Sensitivity Quotient; MT, manual therapy; PDS, Perception of Dizziness Symptoms; TCVR, Tai Chi vestibular rehabilitation; VR, vestibular rehabilitation; VAS, visual analog scale; VDB, vertigo, dizziness, and balance disorders.

Table 3
Summary of alternative treatments of hearing loss

Symptom	Alternative Medicine Interventions	Study	Study Nature	Sample Size	Key Findings
Hearing loss	<i>Ginkgo biloba</i>	Koo et al, ⁴¹ 2016	Randomized controlled trial	56 Patients	Association between systemic steroids and EGb761 showed no superiority when compared with steroids alone in pure tone threshold The words recognition score improved in combination therapy
	Acupuncture	Zhang et al, ⁷⁶ 2015	Meta-analysis	12 Randomized controlled trials	Manual acupuncture combined with conventional medicine comprehensive treatment was better than conventional medicine alone in treating patients with SSNHL
		Chen et al, ⁷⁷ 2019	Meta-analysis	20 Randomized controlled trials	EA, EA + conventional medicine, and MA + conventional medicine were superior to conventional medicine alone for the treatment of SSNHL
	HBOT	Huang et al, ⁸² 2021	Randomized controlled trial	102 Patients	IVS + HBOT: better hearing recovery rate compared with the control group within the first 7 days No significant improvement of tinnitus
		Alimoglu et al, ⁸³ 2011	Clinical trial	217 Patients	Patients receiving oral steroids + HBOT had higher chances to recover than patients receiving oral or IV steroids or HBOT alone
		Rhee et al, ⁸⁴ 2018	Meta-analysis	19 Clinical trials	Patients with severe to profound hearing loss may benefit from the adjunction of HBOT to conventional medical treatment
		Bayoumy et al, ⁸⁵ 2019	Review	68 Studies	HBOT can be used as an optional therapy in patients with acute hearing loss (idiopathic or acoustic trauma)
		Eryigit et al, ⁸⁶ 2018	Systemic review	16 Studies	No significant difference was found between the intervention and control groups. However, patients with severe to profound hearing loss may benefit from the combination of steroids and HBOT

Abbreviations: EA, electroacupuncture; HBOT, hyperbaric oxygen therapy; IV, intravenous; IVS, intravenous steroid; MA, manual acupuncture.

habituation exercises in vestibular dysfunction. The investigators concluded that both practices were effective in reducing dizziness. Furthermore, greater improvement in the Motion Sensitivity Quotient was seen with yogasanas and greater improvement in the Dizziness Handicap Inventory (DHI) with stabilization and habituation exercises.¹⁷ Based on the limited available data, yoga may have a beneficial effect on dizziness and tinnitus, but more confirmatory studies are needed to evaluate their efficacy.

NEUROFEEDBACK

Several neuromodulation techniques,¹⁸ including neurofeedback, have been used to target tinnitus.¹⁹ Neurofeedback is a form of biofeedback that measures the patient's brain activity and then generates audiovisual feedback in real time so the patient can reinforce his or her brain activity consciously via operant conditioning.²⁰ Interestingly, as reported in a randomized controlled study, an increase in alpha activity via neurofeedback training led to a decrease in tinnitus-related distress and loudness.^{21,22} Similar results were found in a randomized controlled study comparing continuous with intermittent neurofeedback. This study showed that continuous feedback is superior to intermittent feedback in the long term; the TFI score significantly improved after all the sessions and patients felt more relaxed.²³ Targeting larger tinnitus-implicated areas in the brain might lead to even better outcomes; therefore, individualized neurofeedback training could potentially be a promising therapeutic option in the treatment of tinnitus.²⁴

HYPNOSIS

Although the studies testing the effect of hypnosis on patients with tinnitus have been scarce, the few available ones demonstrated a positive result in the treatment of troublesome tinnitus. The largest study using Ericksonian hypnosis (EH) included 393 patients with subacute and chronic tinnitus who were treated within an inpatient closed group over 28 days, and compared with a waiting-list control group. The severity of the tinnitus was measured by Tinnitus Questionnaire (TQ) up to 12-month follow-up. Considering that the minimal clinically important difference of TQ changes was estimated to a reduction of at least 5 points,²⁵ significant improvement in TQ was observed compared with the waiting-list group with a mean reduction of 15.9 and 14.1 in the subacute and chronic tinnitus groups, respectively.²⁶ Two other trials by Maudoux and colleagues²⁷ and Yazıcı and colleagues,²⁸ verifying the effect of EH in an outpatient setting, have achieved similar results with less overall session time and a significant reduction in THI scores compared with admission, thus showing hypnosis efficacy. This area is still underresearched; however, preliminary results are promising.

PHYSICAL THERAPY

Studies have shown that patients with vestibular dysfunction improve with vestibular rehabilitation (VR).^{29–31} In a systemic review, with 1876 patients, Regauer and colleagues³² concluded that VR in any modality (Table 2), except Tai Chi and manual therapy, was superior to usual care in treating older patients with vertigo, dizziness, and balance disorders. Moreover, Liu and colleagues³³ investigated the effect of VR on brain activity in patients with vestibular migraine (VM), using resting-state functional MRI. The results showed a significant decrease in the DHI scores and an increase in the 36-Item Short Form Health Survey scores after VR training. The amplitude of low-frequency fluctuation was significantly higher in the left posterior cerebellum

compared to baseline in patients with VM, asserting that the cerebellum may play a role in vestibular compensation.³³ These studies demonstrated the benefits of VR in improving vestibular symptoms and QOL.

SUPPLEMENTS

Ginkgo biloba

There are several contradictory studies on the effectiveness of *Ginkgo biloba* (GB) as a treatment for tinnitus. The active ingredient has been identified as EGb761.³ In the studies that do not show superiority of GB over placebo, the herbal supplement was used in its nonstandardized form (other than GB extract EGb761) or with a lower dose than clinically indicated (<240 mg twice daily).³⁴ Otherwise, most studies have shown the efficacy of GB extract EGb761 as a treatment for patients with tinnitus.^{35–38} A randomized placebo-controlled trial investigating the benefit of EGb761 in patients with dementia with tinnitus showed a direct positive effect on the severity of tinnitus, and an indirect positive effect by improving depression, anxiety, and cognition.³⁶ In a meta-analysis of 5 trials, Spiegel and colleagues³⁷ reported that EGb761 displayed significant therapeutic outcomes over placebo after 20 weeks of treatment in terms of tinnitus and dizziness in patients with dementia (at the end of the treatment, the 11-point box scales for tinnitus and dizziness were reduced by 1.06 and 0.77, respectively). EGb761 improves cerebral and cochlear blood flow³⁹ as well as mitochondrial functioning⁴⁰—the desired effect in elderly patients with impaired perfusion and mitochondrial function. Furthermore, Radunz and colleagues³⁸ demonstrated an improvement in tinnitus severity and loudness after a 3-month period of treatment with GB and/or hearing aids, with no synergism between the treatments.

EGb761 was also tested in a randomized placebo-controlled trial in patients with idiopathic SSNHL. Although adjuvant systemic steroids with EGb761 showed no superiority when compared with steroids alone in pure tone threshold, the words recognition score improved in combination therapy.⁴¹ Finally, in a randomized, double-blind trial, Sokolova and colleagues⁴² found that EGb761 was as effective as betahistine in the treatment of unspecified vertigo in all outcome measures. EGb761 was also found to be superior to placebo in vestibular and nonvestibular vertigo. This superiority was measured by different means such as vertigo score (intensity, duration, frequency), global assessment of patients (visual analog scale [VAS]), caloric test, and sway amplitude in the craniocorpography and posturography.⁴³ In addition, following a unilateral labyrinthectomy in rats, oral supplementation with EGb761 was shown to be effective on the compensation of static and dynamic vestibular function (nystagmus, postural asymmetry, and locomotor behavior).⁴⁴ A bimodal therapy consisting of the combination of EGb761 with vibrotactile neurofeedback resulted in improvement in age-related vertigo and dizziness after 6 weeks of treatment. In addition, no safety issues were reported.⁴⁵ These results should be confirmed in future clinical trials.

Zinc

Studies have shown that the inner ear, especially the stria vascularis, has a high zinc content, which protects the cochlea from injury due to reactive oxygen species, and that a low serum level of zinc could lead to otologic disorders, such as tinnitus, imbalance, and hearing loss.^{34,46} In a large study, using data from the Korea National Health and Nutrition Examination Survey, Jun and colleagues⁴⁷ found that serum zinc levels were significantly lower in patients with severe tinnitus only and that low serum zinc levels were not correlated to tinnitus in the other subpopulation (mild tinnitus, moderate tinnitus, and control group). Similarly, Berkiten and colleagues⁴⁸ showed by using

the tinnitus severity index questionnaire that lower serum zinc levels were associated with increased severity and loudness of tinnitus. In addition, they demonstrated that serum zinc levels decrease as age increases and that an increase in hearing thresholds is associated with low serum zinc levels.⁴⁸ In 2 randomized placebo-controlled trials, zinc supplementation was not more effective than placebo in treating elderly patients with tinnitus.^{49,50}

In a study by Ferreira and colleagues,⁵¹ which included patients with zinc deficiency, it was demonstrated that hypozincemia possibly affected the function of vestibulo-ocular, vestibulocerebellar, and vestibulocortical pathways when tested using videonystagmography. The investigators suggested that zinc may affect the functioning of the vestibular system.⁵¹ Overall, the advantage of supplementing zinc in the treatment of migrainous ear disorders remains an item of debate and requires further assessments.

Vitamin B and Antioxidants

Recent studies have shown a correlation between migraine headache and various vestibular disorders (Meniere disease [MD],⁵² benign paroxysmal positional vertigo,⁵³ and mal de débarquement syndrome⁵⁴). As such, it has been shown that treating MD with a migraine diet and lifestyle modifications (preventing dehydration, starvation, and sleep disturbances; avoiding certain foods such as chips, cheese, chocolate, nuts, processed meats, certain fruits, and pickled fruits or vegetables), as well as supplementation with vitamin B₂ and magnesium can control vestibular and cochlear symptoms.⁵⁵ Similarly, patients with tinnitus can benefit by preventing dehydration and avoiding certain foods such as caffeine, alcohol, processed meats, monosodium glutamate (found in soy sauce or pickled foods), aspartame, avocado, and chocolate.^{56,57} Furthermore, Lee and Kim⁵⁸ reported that less vitamin B₂ intake in young ages was associated with tinnitus, whereas less intake of vitamin B₃ in the elderly was significantly associated with tinnitus-related annoyance. The investigators recommended that supplementation with vitamin B₂ and B₃ might be considered in conjunction with conventional pharmacologic therapy or CBT while managing tinnitus in patients.⁵⁸ Vitamin B₁₂ is an essential cofactor for myelin sheath formation, thus preventing neuronal dysfunction peripherally and centrally. Seidman and Babu⁴ believe that there might be an association between vitamin B₁₂ deficiency and increased prevalence and severity of tinnitus in the elderly, because supplementation with vitamin B₁₂ showed some relief. Consistently, in a randomized, double-blind clinical trial, patients with tinnitus and cobalamin (vitamin B₁₂) deficiency, receiving vitamin B₁₂, showed a significant improvement in the VAS and tinnitus severity index (TSI) after treatment with vitamin B₁₂.⁵⁹ It has been also demonstrated that following 1 month of treatment with vitamin B complex, the amplitude of the distortion product otoacoustic emissions increased with clinical improvement, especially in patients with tinnitus.⁶⁰ Similarly, using the UK Biobank resource, Dawes and colleagues conducted a study to evaluate the role of diet in tinnitus and hearing disorders. There were associations between a high intake of vitamin B₁₂ and protein with a reduced likelihood of tinnitus, whereas high calcium, iron, and fat intakes were associated with an increased likelihood of tinnitus.⁶¹

Besides B vitamins, and based on the theory that reactive oxygen species contributed to tinnitus, Ekinçi and Kamasak⁶² supported the use of antioxidants. A clinical trial demonstrated that supplementing patients with low plasma coenzyme Q10 (CoQ10) levels and chronic tinnitus with CoQ10 may decrease tinnitus.⁶³ In addition, it has been reported in 2 meta-analyses that CoQ10 supplementation significantly reduced the duration and frequency of migraine headache attacks, without a

significant effect on severity, when compared with the control group.^{64,65} Patients with tinnitus, vertigo, and poor hearing may benefit from supplementation with some vitamins and certain antioxidants.

Melatonin

The precise mechanism of action of melatonin on tinnitus is not well known, but it is thought that its favorable outcomes are possibly related to the regulation of the labyrinthine perfusion, reduction of the muscular tone and sympathetic drive, antidepressive effects, and antioxidant effects.^{66,67} Rosenberg and colleagues⁶⁸ performed the first randomized, double-blinded, placebo-controlled trial evaluating the efficacy of melatonin as a treatment of tinnitus. The investigators found that patients with high THI scores and/or difficulty sleeping would benefit from melatonin.⁶⁸ Abtahi and colleagues⁶⁹ demonstrated that melatonin may outperform sertraline in treating tinnitus. The investigators found that after 3 months of 3 mg melatonin once daily or 50 mg sertraline once daily, the THI scores significantly decreased in both groups; however, the decrease was significantly more for melatonin (reduction of THI score from 45 to 30 in melatonin group and from 45 to 37 in sertraline group). These results asserted that both drugs are effective, but melatonin was more helpful especially because no side effects,⁶⁹ apart from nightmares, have been reported to date.³⁴ Along with these findings, Albu and Chirtes⁶⁶ demonstrated that after 3 months of treatment, patients receiving intratympanic (IT) dexamethasone plus melatonin or only melatonin attained statistically significant improvement on the tinnitus loudness score, tinnitus awareness score, THI, Pittsburgh Sleep Quality Index, and Beck Depression Inventory, favoring the IT dexamethasone plus melatonin in patients with acute unilateral tinnitus.⁶⁶ Therefore, it would be desirable to redirect the available evidence through high-quality clinical trials, especially given that in all studies the efficacy of melatonin in tinnitus and associated sleep disturbances has been recognized.^{70,71} It is likely that improvement of sleep may be the primary reason melatonin improves QOL in patients with tinnitus. Melatonin may be beneficial for patients with tinnitus who also suffer from sleep-onset delay.

ACUPUNCTURE

Acupuncture has been widely used to treat tinnitus in Eastern Asian countries.³⁴ It seems that deep acupuncture (needles inserted approximately 10 to 30 mm deep) improved tinnitus symptoms by modulating the sympathetic and parasympathetic nervous system balance.⁷² Another study using infrared thermography test preacupuncture and postacupuncture treatment in patients with tinnitus showed that the efficacy of acupuncture is due to an improvement of cochlear blood flow in both ears even if acupuncture was applied on one side.⁷³ As such, multiple studies have demonstrated the superiority of acupuncture as a treatment of tinnitus when compared with placebo or conventional medication.^{74,75} Additionally, 2 meta-analyses showed a better effect of acupuncture combined with conventional medicine (such as systemic or intratympanic steroids, hyperbaric oxygen, and vasodilators) than conventional medicine alone in the treatment of SSNHL and sudden deafness.^{76,77} Finally, a controlled clinical trial demonstrated that acupuncture reduces the discomfort and VAS of dizziness and vertigo, after 30 minutes of treatment in the emergency department.⁷⁸

HYPERBARIC OXYGEN THERAPY

Cochlear migraine (fluctuating or SSNHL) is a new concept that was first described in 2018.^{79,80} One of the etiologic hypothesis has been attributed to an abnormal blood

flow to the cochlea.⁸¹ Thus, based on the principle of hypoxia of the inner ear, several studies supported the implementation of hyperbaric oxygen therapy (HBOT) in combination with steroids as a treatment of SSNHL,^{82–85} specifically in patients with severe or profound hearing impairment.⁸⁶ At present, there is mixed evidence in support of HBOT for SSNHL. If there is a benefit, it is best provided early after the onset.

SUMMARY

Several CIM treatment options may be beneficial for migrainous tinnitus, vertigo, and ear symptoms. Although many physicians may be hesitant to consider these treatment modalities, CIM should be used as a complementary approach combined with conventional treatment, especially with patients who did not sufficiently benefit from medical therapy. More randomized controlled studies are needed to define the efficacy of the various CIM therapies on otologic migraine. These studies are best performed by collaboration of neurotologists and CIM specialists. In general, most treatments are well-tolerated with limited side effects. Therefore, CIM should be in the repertoire of every clinician treating otologic migraine.

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