Vestibular Dysfunction in Patients With Chronic Pain or Underlying Neurologic Disorders

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Context: Individuals with vestibular dysfunction are at increased risk for falling. In addition, vestibular dysfunction is associated with chronic pain, which could present a serious public health concern as approximately 43% of US adults have chronic pain.

Objective: To assess the incidence of vestibular dysfunction in patients receiving medication for chronic, noncancer pain or other underlying neurologic disorders and to determine associated follow-up therapeutic and diagnostic recommendations.

Methods: The authors conducted a retrospective medical record review of consecutive patients who were treated in their private neuroscience practice with medications for chronic pain or underlying neurologic disorders in 2011. All patients underwent a series of tests using videonystagmography for the assessment of vestibular function. Test results and recommendations for therapy and additional testing were obtained.

Results: Medical records of 124 patients (78 women, 46 men) were reviewed. Vestibular deficits were detected in 83 patients (66.9%). Patient ages ranged from 29 through 72 years, with a mean age of 50.7 years for women and 52.5 years for men. Physician-recommended therapy and follow-up testing were as follows: 32 patients (38.6%), neurologic examination and possible magnetic resonance (MR) imaging or computed tomography (CT) of the brain; 26 patients (31.3%), vestibular rehabilitation therapy only; 22 patients (26.5%), vestibular and related balance-function rehabilitation therapy, further neurologic examination, and possible MR imaging or CT; 2 patients (2.4%), balance-function rehabilitation therapy and specialized internal auditory canal high-magnification MR imaging or CT to assess for acoustic neuroma; and 1 patient (1.2%), specialized internal auditory canal high-magnification MR imaging or CT to evaluate for possible intracanalicular acoustic neuroma.

Conclusion: Patients being treated with medications for chronic, noncancer pain or other underlying neurologic disorders may have a higher-than-average incidence of vestibular dysfunction. Baseline assessment and monitoring of the vestibular apparatus may be indicated for these patients.

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Vestibular dysfunction is a common, diagnostically challenging condition. The importance of diagnosing and managing vestibular deficits is well established.[1] These deficits are associated with falls, morbidity, diminished autonomy, and increased health care costs, especially among elderly individuals who are at increased risk for gait disturbances, balance disorders, and bone fracture.[1-5] In a cross-sectional study of US adults aged 40 years or older (n=5086) conducted from 2001 through 2004, 35.4% of participants had vestibular dysfunction; those who were clinically symptomatic had a 12-fold increased risk of falling.[1] This finding suggests that routine screening to detect subclinical vestibular dysfunction could allow for early medical intervention and ultimately prevent fall-related injuries and death.[1]

The vestibular system is a multimodal sensory system that is involved in many functions including reflexes and perception and consciousness.[6] The vestibuloocular and vestibulospinal reflexes are essential for maintaining stable vision and posture.[6] Many clinical tests that are used to evaluate balance function are based on an assessment of the vestibuloocular reflex.[7-10]

In our private neuroscience practice, we have observed that patients with impaired signals from the peripheral nervous system, spinal cord, or brain often have impaired balance. For example, patients with spinal stenosis, usually secondary to degenerative disk disease and spondylosis, frequently experience balance impairment. No studies, to our knowledge, have measured the incidence of vestibular dysfunction in patients being treated for these conditions. The aim of the present preliminary study was to assess the incidence of vestibular dysfunction in patients being treated with medications for chronic pain or underlying neurologic disorders and to determine associated follow-up therapeutic and diagnostic recommendations.

Methods

Participants

The present retrospective review was conducted in 2011 at our private neuroscience practice. Medical records were consecutively collected in chronological order according to office visits made to and diagnostic testing conducted at our practice. All patients selected for the study were aged 18 years or older and were being treated with medications for chronic, noncancer pain or underlying neurologic disorders such as spinal stenosis, ruptured disk, spinal instability, spondylolisthesis, spinal cord injury or disorder (ie, multiple sclerosis, myelopathy, and syrinx), peripheral nerve injury or disorder, or brain injury or disorder (eg, stroke, multiple sclerosis, Chiari malformation). All patients with chronic pain or neurologic disorders routinely underwent a series of tests to assess vestibular function. Although some patients were experiencing dizziness, vertigo, imbalance, ataxia, or gait abnormality, the absence of such clinical symptoms did not exclude patients from testing.

Because the present study was retrospective, institutional review board oversight was not required. All participants provided written, informed consent to have deidentified personal health information used for publication.

Procedures

All patients provided a medical history and underwent a physical examination by 1 of our physicians with assistance from a registered nurse, physician's assistant, medical assistant, or radiologic technologist. After the examination, patients underwent a 15- to 20-minute vestibular function assessment, which included a series of standard tests using quantitative videonystagmography (VNG) technology with interface controller (MedTrak Technologies Inc). Because the tests were noninvasive, a physician's presence was not required while procedures were performed. Tests were performed by 2 medical staff members: a radiologic technologist (S.L.) and a certified medical assistant (D.C.). Training of staff was conducted by the manufacturer of the VNG equipment and a board-certified audiologist. Tests included the following:

- **Spontaneous nystagmus test with gaze fixation nystagmus.** Goggles were placed on the patient's head. Eye movement was recorded for 15 to 20 seconds while the patient (1) stared at complete darkness and then (2) stared at a light inside the goggles.
- **Positional nystagmus test in 6 positions.** Eye movement was recorded for 15 to 20 seconds while the patient tracked an hourglass image that moved on an LCD (liquid-crystal display) screen to the following positions: (1) up and to the right, (2) up and to the left, (3) up, (4) down, (5) right to left, and (6) back to the starting position. For each position, the patient concluded the assessment by staring at the final resting position of the hourglass.
- **Optokinetic nystagmus test, bidirectional, foveal or peripheral stimulation.** One lens of the goggles was removed. Eye movement was recorded for 15 to 20 seconds while the patient tracked the movement of lines (1) to the right and (2) to the left across the bottom of an LCD screen.
- **Sinusoidal vertical axis rotational test.** The patient focused 1 exposed eye on 1 area of the LCD screen while the technician rotated the patient's head from side to side; eye movement was recorded for 15 to 20 seconds. Next, the technician rotated the patient's head up and down, and eye movement was recorded for 15 to 20 seconds. Goggles were then adjusted until the patient experienced darkness. With the patient's eyes open, the technician swiveled the patient's chair from side to side for 10 seconds, and a light was turned on in the goggles; the patient was instructed to look at the light while the technician continued to swivel the chair. Eye movement was recorded for 30 seconds. The patient then closed his or her eyes, tilted his or her head down, and shook his or her head from side to side for about 15 seconds. The patient then stopped shaking his or her head, but kept his or her head tilted and opened his or her eyes. After eyes were opened, eye movement was recorded for 20 to 25 seconds.
- **Dix-Hallpike test for vertigo.** This test was administered to determine whether vertigo was triggered because of head movement. In a seated position with his or her head turned slightly up and to the right, the patient laid down. Eye movement was recorded for 30 seconds, starting when the patient started to lie down. Next, eye movement was recorded for 20 to 30 seconds as the patient rolled to each of the following positions from supine: (1) to the right, (2) to the left, and (3) back to center.
- **Caloric vestibular testing.** The test was conducted using an air gun for the ear (ATMOS Varioair). Each irrigation (binaural, bithermal stimulation) constituted 4 tests. Cool air was introduced into the patient's right ear canal for 60 seconds, after which eye movements were recorded for 30 to 40 seconds. This procedure was repeated for the left ear using cool air, and then repeated for the right and the left ears using warm air.

All VNG tests were recorded, and the ability of the patients' eyes to maintain a static position and follow moving targets was assessed by an audiologist, medical staff, and the patient's attending physician. On the basis of the results, physicians and medical staff made recommendations for vestibular rehabilitation therapy, if indicated. If a patient's symptoms did not improve after therapy, the underlying diagnosis was further investigated and the patient's medications were reviewed and adjusted accordingly to improve function. Test results and recommendations for vestibular dysfunction therapy and follow-up diagnostic testing were entered and organized in a spreadsheet (Microsoft Excel 2010). Findings were examined using descriptive statistics by a medical student (M.V.).

Results

A total of 124 patients (46 men and 78 women) were included in the study. Patients ranged in age from 29 to 72 years, with a mean age of 52.5 years for men and 50.7 years for women. Vestibular deficits were identified in 83 patients (69.9%). Of those, 32 (38.6%) received a recommendation for further neurologic examination and possible magnetic resonance (MR) imaging or computed tomography (CT) of the brain, and 26 (31.3%) received a recommendation for vestibular rehabilitation therapy only. Twenty-two patients (26.5%) received a recommendation for vestibular and related balance-function rehabilitation therapy, further neurologic examination, and possible MR imaging or CT. Two patients (2.4%) received a recommendation for balance-function rehabilitation therapy and specialized internal auditory canal high-magnification MR imaging or CT to assess for acoustic neuroma. One patient (1.2%) received a recommendation for specialized internal auditory canal high-magnification MR imaging or CT to evaluate for possible intracanalicular acoustic neuroma.

Comment

In our study, 66.9% of patients who were being treated with medications for chronic noncancer pain or underlying neurologic disorders had vestibular deficits. Considering that vestibular dysfunction prevalence has been reported to be 35.4% in US adults aged 40 years or older,[1] this finding could potentially suggest a greater-than-average incidence of vestibular dysfunction in patients being treated for these conditions. An association between chronic pain management and vestibular dysfunction has substantial public health implications; a World Health Organization study published in 2008 found that chronic pain affects 43% of the US adult population.[11] Moreover, prevalence rates for chronic pain are expected to increase with the aging of the population, the rising rates of obesity, and the growing number of people who survive catastrophic injuries as a result of modern medicine.[12]

Chronic pain has been shown to modify postural control in patients with low back pain, leading to a deficit in postural adaptability and requiring increased cognitive investment to maintain balance.[13] In addition, there is growing evidence for recurrent balance dysfunction related to migraine headache.[14] Chronic pain has also long been recognized to adversely affect brain function. For example, untreated chronic pain is known to cause some degree of brain atrophy, which could potentially play a role in impairing balance function.[15-23]

Brain function and vestibular function are interdependent. Brain atrophy is often seen in patients with addiction and may be linked to vestibular deficits.[24] Cognitive deficits such as poor concentration are known to occur frequently in patients with vestibular deficits.[25] These types of cognitive deficits may be difficult to differentiate from the cognitive deficits commonly linked with chronic pain or certain medications. In the case of chronic pain, attention and memory deficits may have clinical implications. For example, Seo et al[26] found that working memory deficits in fibromyalgia patients may be associated with reduced activation in several brain regions (ie, frontoparietal memory network).[26] Hanes and McCollum[25] argue that the relationship between cognitive and vestibular functions is not simply indirect, but that many cognitive functions may be directly dependent on the vestibular system. Future studies are warranted to evaluate the usefulness of vestibular function measurement for objectively assessing global neurologic function in patients who are receiving medication therapy for chronic pain or other underlying neurologic disorders.

Because the causes of vestibular deficits are most often multifactoral, to our knowledge there is no simple algorithm for evaluating patient balance, dizziness, or vertigo, and there are no clear-cut, peer-reviewed, evidence-based guidelines for treating such patients.[27] For example, the nystagmus of central vestibulopathy can be vertical, whereas the nystagmus of peripheral vestibular disorders can be rotary with a horizontal or vertical component. Although an accurate history and thorough physical examination may lead to a diagnosis in many patients, physical examination alone has been shown to contribute little diagnostic information in 24% to 31% of patients with vestibulopathy.[28] For patients who may be at risk for falls, Jacobson et al[29] recommend assessment of the vestibuloocular reflex using examinations including caloric testing and, where available, rotational testing.

The VNG technology used in the present study allowed for noninvasive evaluation of eye movements and balance function, and like electronystagmography, it has been shown to be an acceptable method for recording findings during vestibular function testing.[9,10,30-34] The series of tests used in the present study offered a quantitative, objective means for evaluating the complex vestibular system. In the future, VNG and electroznystagmography may also offer noninvasive, objective means for assessing drug intake, as drug-specific waveforms—termed *drug-evoked potentials*—have been identified for alcohol, marijuana, cocaine, tranquilizers, amphetamines, barbiturates, opiates, and hallucinogens.[28-36]

As previously mentioned, vestibular dysfunction has been attributed to increased risk for falling, especially in the elderly population. For example, in a study of 66 consecutive, healthy patients (mean age, 67.8 years) who had sustained a wrist fracture at some time in a 10-month period, the frequency of vestibular asymmetry was higher than that in a group of 49 healthy participants (mean age, 74.9 years) ($P<.001$).[3] Likewise, research suggests that vestibular asymmetries may contribute to falls and hip fractures in the elderly.[2] Individualized vestibular rehabilitation physical therapy and balance strategy training programs have been known to improve balance, decrease fall risk, and improve gaze stability in patients with vestibular dysfunction.[28,37,38]

The high incidence of vestibular deficits found in our study population, together with the heightened risk of injury associated with vestibular dysfunction, supports baseline evaluation and follow-up assessment of vestibular function in patients receiving medication for noncancer chronic pain or other neurologic disorders. Vestibular function assessment can help determine the need for vestibular rehabilitation therapy, further neurologic workup, or diagnostic imaging with the goal to prevent fall-related injuries and associated health care expenses.[34,39,40]

Quantitative, noninvasive assessment of this at-risk patient population may also provide an opportunity for additional research on osteopathic manipulative treatment (OMT) for managing falls, gait disturbances, and balance disorders.[4,41] In recent years, a few small clinical studies[4,41-43] have revealed improvements in vertigo and balance with OMT. However, substantial challenges remain in conducting clinical trials that are adequately powered and that can account for the individualized nature of OMT. Further understanding of the duration of OMT's effect on balance function is also necessary to develop meaningful experimental designs.[4]

A limitation of the present study was that it was not blinded; patient identifiers were available to all physicians who reviewed VNG test results and to the medical student who analyzed the data. In addition, recommendations for therapy or additional testing were made by the patients' individual physicians. Although our practice has internal protocols for recommending follow-up studies based on VNG results, there is an unavoidable degree of subjectivity involved in making these recommendations. Between-operator differences in administering the quantitative VNG tests were not assessed. Our preliminary study sample size was relatively small, from a single patient setting, and represented a range of causes that are linked with vestibular dysfunction. Thus, our investigation was not powered to make quantitative cause-and-effect statements about the prevalence of vestibular dysfunction in all patients being treated for chronic noncancer pain or other neurologic disorders. Studies with larger patient populations are necessary to identify specific types of chronic pain or neurologic disorders that present the highest risk for dysfunction.

Conclusion

Our findings suggest that baseline assessment and monitoring of the vestibular apparatus in patients receiving medication for chronic pain or underlying neurologic disorders could be valuable in determining the need for vestibular rehabilitation balance therapy, medication adjustment, further neurologic examination, or diagnostic imaging. Larger, more detailed studies are warranted to identify chronic pain and neurologic disorders that present the highest risk for dysfunction, to confirm the rates measured in our relatively small sample size, and to consider the potential usefulness of VNG testing to assess global neurologic function in these patients.

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