Vestibular Migraine Following Radiosurgery for Vestibular Schwannoma

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Abstract

Vestibular schwannoma (VS) is associated with dizziness and vertigo during all stages of treatment. This report describes a patient who presented with a one-year history of intermittent motion sickness, dizziness, headache, imbalance, and nausea. MRI showed a right-side VS in the cerebellopontine angle and internal auditory canal. The patient elected to undergo Gamma Knife radiosurgery for treatment. Within two to three months, she continued to experience recurring dizziness, vertigo, neck stiffness, and head pressure. She was referred for neurootology evaluation, which led to a diagnosis of vestibular migraine (VM). Her vestibular reflexes were intact. Subsequently, she was treated with diet modification and low-dose venlafaxine. She reported dramatically improved dizziness and vertigo symptoms at six-month follow-up. VM is a very common cause of dizziness that should always be included in the differential diagnosis, even in VS patients.

Categories: Otolaryngology, Radiation Oncology, Neurosurgery
Keywords: vestibular migraine, radiosurgery, vestibular schwannoma, venlafaxine

Introduction

Vestibular schwannoma (VS) is a benign and typically unilateral tumor of the eighth cranial nerve. As such, VS patients commonly present with hearing loss (68%-94%), tinnitus (30%-83%), and vestibular dysfunction (49%-75%), manifesting as dizziness and/or vertigo [1, 2]. Using cross-sectional data, Carlson et al. show that over 60% of subjects experience long-term dizziness, with risk factors including female sex, older age, and pre-existing dizziness or migraine [3]. A histologic study has shown that VS is associated with atrophy of the vestibular ganglion, peripheral vestibular nerve branches, and vestibular neuroepithelia [4]. Therefore, it is evident that VS can cause dizziness through direct damage to the vestibular nerves or sensory epithelia.

Vestibular migraine (VM) is increasingly recognized as a common cause of dizziness and vertigo, and diagnostic criteria have been adopted by the Bárány Society and International Headache Society. VM is diagnosed based on having at least five episodes of vestibular symptoms that last 5 minutes to 72 hours, a concurrent or past history of migraine with or without aura, and one or more migrainous features in at least half of the vestibular episodes [5]. VM patients often report worsening of vertigo, imbalance, and disequilibrium with increased physical activity and head movements [6]. In a recent epidemiological study in the United States, 2.7% of the adult population was found to have VM [7].

There are three main treatment modalities for VS: microsurgery, stereotactic radiosurgery (SRS), and observation. Notably, SRS has been suggested as a highly effective and safe option for treating small and medium-sized VS [8]. After surgery or SRS, patients can experience acute vestibular symptoms, including vertigo, dizziness, and imbalance, that significantly impact their quality of life [9, 10]. While vestibular hypofunction is the likely cause in many cases, it is always important to maintain a wide differential diagnosis. This report describes a unique VS patient who had recurring dizziness before and after SRS using Gamma Knife. She was subsequently diagnosed with VM, which was successfully managed with diet modification and migraine prophylactic medication.

Case Presentation

A 57-year-old woman initially presented with a one-year history of motion sickness and headache. She also experienced intermittent nausea, dizziness, imbalance, clouded thinking, fatigue, and head pressure. These symptoms often began within one hour of waking up in the morning and could last up to four days. Although she previously attended vestibular physical therapy, she had difficulty performing some of the exercises due to her sensitivity to positional changes. She also had a history of chronic right neck stiffness, headaches with photophobia during periods of nausea and dizziness, and occasional tinnitus and otalgia. She was otherwise healthy, and followed a ketogenic diet and exercise program for weight control. She took the following oral medications: dimenhydrinate 50 mg as needed for motion sickness, zolpidem 10 mg nightly, multivitamin daily, turmeric one capsule daily, magnesium 200 mg daily, and calcium carbonate supplements with vitamin D 625 mg-125 IU twice daily. Her past surgical history includes bunionectomy, coloscopy, and...
tonsillectomy. She smoked 1/4 pack of cigarettes per day for 2.5 years during her adolescence and would consume 0.8 standard drinks of alcohol per week. There was a family history of Alzheimer's disease and heart disease. Her review of symptoms was otherwise unremarkable.

During the initial visit with her primary care provider, the patient reported new nausea with a sudden onset that would occasionally turn into a migraine headache with vertigo. She also reported new mild dyspnea with exertion. As part of her workup, a MRI of her brain was obtained, which showed an 11 x 12 x 9 mm homogeneously enhancing mass at the right cerebellopontine angle and proximal internal auditory canal, suggestive of VS (Figure 1). An audiogram showed normal hearing bilaterally with 100% word recognition score in both ears. She was referred to neurosurgery for evaluation and was prescribed meclizine 25 mg by mouth up to three times daily for dizziness and nausea.

**FIGURE 1: Pre-stereotactic radiosurgery MRI**
Axial T1 post-contrast image shows a right-side cerebellopontine angle tumor measuring 11 x 12 x 9 mm.

After consideration of the three treatment modalities, she elected to undergo SRS using Gamma Knife. She received 12.5 Gy dose to a target region 11 x 13 x 10 mm encompassing the right VS. She tolerated the treatment well. About a month after SRS, she had recurring dizziness, vertigo, neck stiffness, and head pressure. The dizziness was described as either a spinning sensation or a sense of disequilibrium. She was prescribed diazepam 1 mg by mouth daily for symptomatic relief, but it was not effective. She was also given a course of dexamethasone 2 mg by mouth daily, but that also did not alleviate symptoms. She continued to experience dizziness, vertigo, nausea, intermittent headaches with sensitivity to light and sound, and occasional sharp right ear pain. She reported that these symptoms were affecting her mood as well.

She was then referred to neurotology for evaluation. Examination of her head and neck did not show any masses. Otomicroscopy was normal. Examination of cranial nerves, including extra-ocular movements, facial movement and sensation, tongue and palate movement, and shoulder shrug, was normal. A 512-Hertz tuning fork was used for the Weber test, which was midline (normal), and the Rinne test, which showed air > bone conduction bilaterally (normal). Vestibular function was assessed with the head impulse test, which was normal. She did not have nystagmus or dizziness in the Dix Hallpike position. Cerebellar examination, including finger to nose testing, rapid alternating movements, and heel to shin testing, was normal. Romberg, with eyes open or closed and with feet together or tandem, showed normal balance. A Timed Up and Go was completed in nine seconds (normal range) with normal gait. Post-treatment audiogram showed no changes compared to baseline.

With her normal vestibular and cerebellar function, personal history of migraine without aura per International Classification of Headache Disorders, Third Edition (ICHD-3) criteria, and episodic vestibular
symptoms associated with headache and light and sound sensitivity, the patient was diagnosed with VM per Bárány Society criteria. Treatment options were discussed, including both pharmacologic and non-pharmacologic paradigms. Due to the severity of symptoms, she elected to do both. A standard handout was provided with recommendations on migraine trigger avoidance, including stress reduction, sleep hygiene, and a migraine elimination diet. The diet change was suggested to avoid any food triggers of her migraines. In addition, medications were discussed with her, and she elected to try venlafaxine 37.5 mg by mouth daily. At first, she reported feeling increased brain fog and head pressure after taking a full tablet of venlafaxine. Therefore, her dose was adjusted to a half tablet.

In a follow-up visit three months later, she reported much improved symptoms. Her subjective assessment was that she felt 90% better. She had been avoiding social activities and exercise, which she was able resume after treatment of her VM. Occasionally, certain head movements or positions, such as moving her head up and down, or the “downward dog” yoga position, could trigger symptoms. Her post-SRS MRI showed no significant changes in the size of the right VS, with development of a central necrosis (Figure 2). Further communication six months after treatment showed continued dizziness relief with her treatment regimen.

![Post-stereotactic radiosurgery (SRS) MRI](image)

**FIGURE 2: Post-stereotactic radiosurgery (SRS) MRI**

Axial T1 post-contrast image demonstrating the right vestibular schwannoma with a central necrosis, after SRS using Gamma Knife.

### Discussion

This report describes a patient treated with SRS using Gamma Knife for a VS, who had recurring dizziness, vertigo, neck stiffness, and head pressure. She was diagnosed and treated for VM, which resulted in significant improvement in her symptoms.

Dizziness in VS patients is a commonly experienced symptom that could be related to a variety of causes other than the tumor itself. In a retrospective cohort study on examining secondary causes of vertigo in VS patients at a tertiary center, Sahyouni et al. found that 78% had comorbid VM [11]. Therefore, it is imperative to evaluate dizziness in VS patients using a wide differential diagnosis as part of their workup and treatment. The nature of symptoms should also be clarified, as dizziness can be used non-specifically. For example, dizziness should be distinguished from pre-syncpe, orthostasis, and lightheadedness. Furthermore, many medications can cause dizziness as a side effect. Table 1 summarizes the differential diagnosis for dizziness and vertigo, along with treatment options for each specific diagnosis.
| Diagnosis                        | Diagnostic Clues                                                                 | Treatment Options                                                                 |
|---------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Vestibular migraine             | Motion intolerance on exam, light sensitivity                                     | Lifestyle changes, diet modification, migraine prophylactic therapy                |
| Cerebellar dysfunction          | Oculomotor dysfunction, dysmetria, ataxia, dysdiadochokinesia                    | Tumor removal, aminopyridines, vestibular physical therapy                         |
| Hydrocephalus                   | Headache, vomiting, nausea, positional vertigo, MRI showing effacement of fourth ventricle and dilated lateral ventricles | Tumor removal, shunt                                                              |
| AICA stroke                     | Oculomotor dysfunction, unilateral hearing loss, ataxia, facial weakness, Horner’s syndrome, crossed hemisensory loss | Thrombolysis, anticoagulants, supportive care                                      |
| PICA stroke                     | Oculomotor dysfunction, unilateral hearing loss, ataxia, facial weakness, Horner’s syndrome, crossed hemisensory loss, dysphagia | Thrombolysis, anticoagulants, supportive care                                      |
| Unilateral vestibular hypofunction | Vestibular testing (HIT, VNG, rotary chair testing)                                      | Vestibular physical therapy                                                  |
| Bilateral vestibular hypofunction | Vestibular testing (HIT, VNG, rotary chair testing)                                      | Vestibular physical therapy                                                  |
| Benign paroxysmal positional vertigo | Dix-Hallpike test                                                                           | Epley maneuver                                                                  |
| Superior canal dehiscence syndrome | CT scan, VEMP, audiometry                                                      | Surgical plugging or resurfacing of dehiscent canal                  |
| Mal de debarquement syndrome    | Patient history of disequilibrium (rocking and swaying sensation)                   | Vestibular physical therapy, stress reduction, SSRI                              |
| Ménière’s disease               | Audiometry and history                                                             | Low salt diet, oral steroids, diuretic, vestibular physical therapy, intratympanic steroids, intratympanic gentamicin |
| Perilymphatic fistula           | Audiometry, VNG, VEMP, history of trauma                                            | Surgical reinforcement of round and oval windows with tissue grafts               |
| Persistent postural perceptual dizziness | Chronic imbalance and dizziness, behavioral assessments                                      | SNRI, SSRI, vestibular physical therapy, cognitive behavioral therapy       |
| Psychiatric causes of dizziness | Behavioral assessments, vestibular testing                                        | Per underlying condition                                                        |
| Vestibular paroxysmia           | MRI, audiometry, VEMP, VNG, auditory brain stem test                                 | Oxcarbazepine, carbamazepine                                                   |
| Presbyvestibulopathy            | HIT, postural instability, recurrent falls, vestibular testing, gait disturbance     | Vestibular physical therapy                                                  |

**TABLE 1: Differential diagnosis for dizziness in the setting of vestibular schwannoma (VS).**

The diagnosis, diagnostic clues, and treatment options are listed for distinct vestibular etiologies that should be considered for VS patients experiencing dizziness and vertigo.

AICA, anterior inferior cerebellar artery; HIT, head impulse testing; PICA, posterior inferior cerebellar artery; SNRI, serotonin norepinephrine reuptake inhibitor; SSRI, selective serotonin reuptake inhibitor; VEMP, vestibular-evoked myogenic potential; VNG, videonystagmography.

First, dangerous causes of dizziness must be ruled out. These include hydrocephalus and cerebellar stroke, which can involve an acute onset of dizziness. VS patients with associated hydrocephalus may present with headache, vomiting, nausea, positional vertigo, and MRI showing effacement of the fourth ventricle and dilated lateral ventricles. Treatment options include ventricular shunting and tumor removal. With anterior...
Dizziness is one of the most significant predictors of quality of life in VS patients [10,16,17]. Lee et al. report that 32% of VS patients developed vestibular dysfunction within six months of SRS [18]. This highlights the importance of dizziness evaluation and treatment as part of the comprehensive management of VS. A recent interventional study reports that all patients with VS and comorbid VM had complete symptomatic resolution of their vertigo after being treated with migraine prophylactic therapy (e.g., verapamil, topiramate, nortriptyline) and undergoing migraine diet and lifestyle changes [11]. In a non-placebo randomized controlled trial, both venlafaxine and propranolol were found to reduce vertigo episodes and severity in VM patients. Venlafaxine additionally led to decreased depressive symptoms [6,19]. In a larger study of subjects with migraine-associated dizziness, nortriptyline combined with dietary manipulation (avoidance of processed cheese, meat, and red wines) was found to completely resolve or reduce symptoms in 77% of subjects undergoing this treatment regimen [20]. This improvement from a combined treatment of diet changes and migraine prophylactic medication is consistent with the findings in our report.

Conclusions
This report highlights the significance of carefully evaluating dizziness using a wide differential diagnosis in the setting of VS. Our patient was diagnosed with VM, and subsequent diet modification along with pharmacologic treatment led to a significant reduction in symptoms.

Additional Information
Disclosures

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