

# Vestibular Rehabilitation

## Introduction

# Physiotherapy in River Heights, Winnipeg for Vestibular Rehabilitation

Welcome to River Heights Physiotherapy's guide on Vestibular Rehabilitation.

Luckily, most of us go about our daily lives without any regard for the complexity of our body's systems that keep us upright and balanced. It is not only until one experiences a disruption of their balance that they are reminded how vitally important it is to simple, everyday tasks.



Vestibular rehabilitation therapy (VRT) consists of a set of exercises that encourage the brain and spinal cord to make up for balance or equilibrium deficits, which are present due to inner ear or central nervous system disease or abnormality. VRT exercises are designed specifically for you by a physiotherapist at River Heights Physiotherapy who has specialized knowledge in this area. VRT is also referred to as balance retraining therapy.

### **This guide will help you understand:**

- the anatomy of the vestibular system
- why VRT is needed
- which disorders VRT is commonly used for

- what River Heights Physiotherapy's approach to VRT is

## **Anatomy**

The anatomy and physiology underlying the human body's sensation of balance is complex. Many systems are involved including the brain, the spinal cord, the eyes, the ears and the receptors in the skin, joints and muscles. Disruption to any of these areas through injury or disease can affect one's feeling of being balanced.

The inner ear, which is also called the labyrinth of the ear, is made up of three primary structures which moderate balance and equilibrium; the semicircular canals along with the saccule and utricle. Collectively this system of the inner ear is termed the vestibular system or vestibular apparatus. The inner ear also contains the cochlea, which is the main structure involved in hearing.

The three semicircular canals work to detect rotational motion of the head. The canals are positioned at 90-degree angles to one another and are filled with fluid called endolymph. Hair cells are located at the base of each canal and project up into the endolymph. Movement of the head causes movement of the endolymph within the canals, which in turn causes the hair follicles to move accordingly and emit impulses about balance. Hair follicles in the saccule and utricle add to the balance information by providing feedback about the position of the head in reference to gravity (vertical orientation), as well as detecting linear motion of the head.

Sensory information from the inner ear is relayed to the brain via the vestibular portion of the eighth cranial nerve (CNVIII), which is also called the vestibulocochlear nerve. The cochlear portion of the nerve transmits information about hearing. Specific areas of the brain, in particular the cerebellum and brain stem as well as portions of the cortex, process sensory information coming from the inner ear. When both the right and left inner ears are sending the same information, the brain processes that the body is balanced. When the body or head moves, the sensory input from the ears is not identical so the brain perceives motion and the body adjusts accordingly.

The ears work in close relation with the eyes in order to maintain equilibrium and balance. The vestibulo-ocular reflex (VOR) is an automatic function of the eyes, which stabilizes images on the retina in response to the vestibular sensory input from the ears. This reflex causes the eyes to move in the opposite direction to the movement of the head in order for the eyes to remain fixed on a target. Thus, accurate vestibular input from the ears affects how the eyes adjust and to one's sense of being balanced. The accurate relay of information from the eyes along the optic cranial nerve (CN II) to the brain is also required.

If one inner ear is affected by disease or injury then the sensory input being sent to the brain will falsely indicate movement from that vestibular system. In this case the eyes will adjust accordingly and move opposite to the perceived motion despite the head actually being still. An involuntary back and forth movement of the eyes results. This movement of the eyes is called nystagmus and when present, leads any health care professional to suspect a vestibular problem.

Two other reflexes, the vestibulocollic reflex and the vestibulospinal reflex also work to help the body maintain its balance and sense of equilibrium. The vestibulocollic reflex (sometimes called the vestibular-neck reflex) works in conjunction with the vestibular input and the neck muscles in order to stabilize the head. The job of the vestibulospinal reflex is to create compensatory body movements in response to the vestibular input in order to maintain one's balance and avoid falling over.

The brain amalgamates the vestibular information from the inner ears with sensory information from the eyes, as well as the information coming from the receptors in the muscles and joints of the neck and the rest of the body to provide the body with its overall sense of balance within its environment.

Disruption along any portion of the anatomical pathway described above can affect one's perception of balance or equilibrium. A problem with the inner ear portion of the pathway or the sensory information being relayed to the brain via the vestibulocochlear nerve is termed a peripheral vestibular disorder. If the problem affecting one's balance is due to damage of a structure within the brain itself, which then affects the reception and integration of balance information, it is termed a central vestibular disorder.

## **Common Disorders treated with VRT**

The most common peripheral vestibular disorders that are treated by VRT are benign paroxysmal positional vertigo (BPPV), and any injury or disease that results in a reduced inner ear function. This reduced function may be associated with disorders such as Ménière's disease, vestibular labyrinthitis or neuritis, or an acoustic neuroma. The term unilateral or bilateral vestibular hypofunction may be used in describing the reduced function of the vestibular system in one (unilateral) or both (bilateral) ears due to disease or injury.

Clinically, any peripheral dysfunction in the vestibular system, which affects one's balance can potentially be treated with VRT, however the effectiveness of the treatment will depend on the exact cause of the vestibular issues.

Central vestibular disorders such as Multiple Sclerosis or stroke may also respond to VRT, although generally peripheral vestibular disorders tend to respond better.

## **Benign Paroxysmal Positional Vertigo (BPPV)**

BPPV is a common clinical disorder of balance, which is characterized by recurrent vertigo spells that are brief in nature (usually 10-60 seconds) and are most often triggered by certain head positions. Benign, in medical terms, means it is not threatening to life. Paroxysmal means it comes with a rapid and sudden onset or increase in symptoms.

BPPV is the most common cause of recurrent vertigo. The cause of BPPV is proposed to be calcium carbonate crystals (termed otoconia, otoliths, canaliths or 'ear rocks') within the semicircular canals of the inner ear. In normal circumstances these crystals are located within the utricle and saccule of the ear but in BPPV it is thought that these crystals dislodge and migrate to the semicircular canals of the ear. The cause of this dislodgement is postulated to be a number of possible reasons such as an ear or head injury, an ear infection or surgery, or from natural degeneration of the inner ear structures. Often, however, a direct cause cannot be identified.

The otoconia settle in one spot in the canal when the head is still. The most common canal for settlement is in the posterior semicircular canal. A sudden change in head position, often brought on by activities such as rolling over in bed, getting out of bed, bending over, or looking upwards, causes the crystals to shift. This shift in turn sends false signals to the brain about equilibrium, and triggers the vertigo.

Vertigo due to BPPV can be severe and accompanied by nausea. The attacks can occur seemingly for no reason and then disappear for weeks or months before returning again. Generally BPPV affects only one ear

and although it can occur at any age it is often seen in patients over the age of 60 and more often in women. Nystagmus is usually present.

## **Meniere's Disease**

Meniere's disease is a chronic incurable vestibular disorder characterized by symptoms of episodic severe vertigo, fluctuating hearing loss, ear 'fullness' and/or ringing in the ear (tinnitus), and nystagmus.

This disease derives its name from a French Physician, Prosper Meniere, who theorized in the late 1800's about the cause of this repertoire of symptoms, which he noted in many of his patients.

The exact cause of Meniere's disease is still not certain but it is theorized that it is due to an abnormal amount of endolymph fluid collecting in the inner ear and/or an abnormal buildup of potassium in the inner ear.

Early-stage acute attacks of Meniere's disease vary in their length anywhere from 20 minutes to 24 hours. The attacks can occur regularly within a week or may be separated by weeks or months. Other symptoms may coincide with the attack such as anxiety, diarrhea, trembling, blurry vision, nausea and vomiting, cold sweats, and a rapid pulse or heart palpitations. Following the attacks patients often feel extreme tiredness, which requires many hours of rest to recover. For some patients time between attacks may be symptom free but other patients report ongoing related symptoms even between attacks.

## **Vestibular Labyrinthitis or Neuronitis**

Vestibular labyrinthitis or neuronitis is an inflammation of the inner ear or its associated nerve (the vestibular portion of the vestibulocochlear nerve), which causes vertigo. Hearing may also be affected if the inflammation also affects the cochlear portion of the nerve.

The vertigo caused by vestibular neuronitis or labyrinthitis is of a sudden onset and can be mild or extremely severe. Nausea, vomiting, unsteadiness, decreased concentration, nystagmus and impaired vision may also occur. Most often the infections that cause inflammation of the inner ear or the vestibulocochlear nerve are viral in nature as opposed to bacterial. Proper diagnosis in regards to it being viral or bacterial is important in order to provide the most effective and appropriate treatment.

## **Acoustic Neuroma**

An acoustic neuroma is a benign (non-cancerous) tumour on the vestibulocochlear nerve. Early symptoms are related to loss of hearing in the affected ear, ringing in the ear (tinnitus), dizziness, and a feeling of fullness in the ear. The tumour is slow growing so symptoms come on gradually and may be easily overlooked in the early stages. As the tumour grows it may push on other nerves in the area and symptoms such as headaches or pain and numbness in the face may appear. Vertigo or other balance issues may arise with growth of the tumour.

## **Vestibular Symptoms**

Peripheral or central vestibular disorders can result in a number of varying symptoms. VRT can potentially alleviate or resolve any symptoms associated with the vestibular disorder. Common symptoms include:

- dizziness
- vertigo
- blurred vision
- fatigue
- anxiety
- headaches
- nausea and/or vomiting
- cold sweats
- ringing in the ears (tinnitus)
- hearing loss
- twitching eyes
- nystagmus
- ear pressure
- panic attacks
- a feeling of being pulled to or leaning to one side
- fear of falling
- increased risk of falls
- impaired balance
- unsteady walking
- anxiety
- depression

## Diagnosis

A detailed history of your problem is the most crucial information needed by your physiotherapist in order to diagnose the cause of your vestibular disorder and then to implement the appropriate VRT.

Your physiotherapist will ask you to describe your vestibular symptoms in detail. Any symptoms listed above that you experience, or others, should be mentioned. Your physiotherapist will want to know when the first episode of your symptoms occurred, how long they lasted, and if they were associated with any other events such as a car accident, head trauma, or an illness or infection. They will also want to know how often you have experienced your symptoms since the first episode, and the general pattern of symptom frequency. Your physiotherapist will ask if anything in particular triggers your symptoms such as moving your head in a certain direction or getting out of bed. In regards to dizziness your therapist will inquire about the nature of what you feel, and whether or not you experience episodes of true vertigo, where you have a sensation of spinning or rotating. Your physiotherapist will also want to know if there is anything that makes your symptoms better, what makes your symptoms the worst, and if you are taking any medications, or if you have a family history of any inner ear disorders or central nervous disorders. They may ask you to rate the intensity of some of your symptoms on an objective scale. Lastly, they will inquire about all the daily activities that are affected by your vestibular problem such as your walking ability, your driving ability, your work activities, and even your home activities such as getting dressed, bathing, showering, and housekeeping. They will also want to know if you have had any falls or almost-falls.

After taking a detailed history your physiotherapist will then perform a physical examination. A general examination of your balance will be completed. They may ask you to stand on one foot or stand with your eyes closed. You may also be asked to lie down and then get up from the lying position in order to determine if this motion brings on your symptoms. They will also want to observe your resting head and neck posture as well as how you walk to assess for any compensatory changes or strategies.

Your physiotherapist will look in your eyes to note any abnormalities of your eye gaze. For any health care

professional, assessing reflexive eye motion is important in order to determine whether the vestibular system is working properly. As explained above, if one inner ear is affected by disease or injury then the sensory input being sent to the brain will falsely indicate movement from that vestibular system. In this case the eyes will adjust accordingly and move opposite to the perceived motion despite the head actually being still. An involuntary back and forth movement of the eyes, called nystagmus, results.

There are a number of tests that your physiotherapist may perform in the clinic in order to determine whether or not nystagmus or irregular eye movement is present. These tests may involve lying you down on the bed while they hold your head still, shaking or rolling your head gently, or positioning your head in specific ways in sitting or lying. In some cases, your physiotherapist may ask you to wear specialized glasses, which enable them to better assess your eye motion. Nystagmus can be caused by several reasons other than vestibular problems, however in the case of accompanying dizziness or vertigo, nystagmus leads your physiotherapist to the suspicion that the vestibular system is the culprit.

Your physiotherapist may also assess the tracking of your eyes by asking you to follow certain objects with your eyes or asking you to move your head while maintaining your focus on a specific target.

A general examination of the joints of your neck will also be completed to determine if any of your symptoms could be coming from the neck region. Other general physical examinations such as blood pressure in both lying and standing may also be assessed.

Finally, your physiotherapist may ask you to fill in a questionnaire that asks you about the intensity of your vestibular symptoms and what provokes them in order to give them a better idea of when your symptoms are at their best and worst.

Depending on what your physiotherapist finds on their initial examination they may send you for a series of other tests to further determine the cause of your vestibular symptoms.

## **Advanced Testing**

### **Electronystagmography**

Electronystagmography (ENG) is a commonly used test to check for signs of nystagmus in more detail.

To conduct this test electrodes are placed around the eyes and the motion of the eyes is recorded as you are asked to follow certain moving targets or while your head is positioned in different directions. A related test is one in which the eye movements are video recorded by wearing goggles rather than electrodes (videonystagmography.)

### **Caloric testing**

During this test, which is a subtest of electronystagmography, cool and warm water or air is administered to each ear, one at a time. The change in temperature stimulates the balance organ in the ear and in normal circumstances your eyes reflexively move in a specific direction depending on whether cool or warm water is administered. Absence of this movement indicates a vestibular problem.

## **Rotation Tests**

Normally each time your head moves one way your eyes move in the opposite direction. During rotation tests electrodes or goggles are used to record how the eyes move while the head is moving at differing speeds. You may be asked to move your head while looking at a fixed target, or a computerized chair may be used to rotate your head while it is restrained.

Simple rotation tests may be administered by your healthcare professional in their clinical setting. For these tests they will observe your eyes while they move your head or rotate you on a swivel chair.

## **Vestibular evoked myogenic potential (VEMP)**

This test is used to confirm whether or not the saccule and part of the vestibular nerve are functioning properly.

During this test headphones are used along with electrodes over the neck muscles. For this test the saccule, which also responds to sound, is stimulated via loud clicks into the headphones rather than via head movements. The response of the neck muscles to the clicks is recorded and indicates whether the sensory impulses are being transmitted properly.

## **Posturography**

Sometimes called computerized dynamic posturography, this test provides information about motor control and balance function during varying unstable conditions. Rather than providing specific information about the vestibular portion of the ear or brain, this test focuses on the feedback needed by the receptors in one's joints, muscles, and skin (proprioception) in order to maintain one's balance.

During this test you are required to stand on a moveable platform and you are asked to focus on a specific target. The platform or the target is then moved while pressure gauges under the platform record and map your body's sway in relation to a neutral standing position.

## **Scans**

In some cases a magnetic resonance imaging (MRI) scan or a computerized tomography (CT) scan of the brain may be done. An MRI scan uses a strong magnetic field and radio waves in order to produce a detailed image. A CT scan uses a series of detailed X-rays to create an image.

These scans can identify abnormal growths affecting the ear (tumors both benign or malignant) or lesions such as those seen in MS.

## **Hearing Tests**

Standard hearing tests are often carried out when delineating the cause of vertigo due to the close relation between the hearing and balance organs and nerves of the ear.

## **Vestibular Rehabilitation Therapy Exercises**

As indicated above, a wide variety of disorders that cause dizziness or imbalance can be treated with VRT. Virtually any disorder that is due to a vestibular dysfunction, and is not being well compensated for, can be

treated with VRT. Effectiveness of VRT depends on a proper diagnosis of the cause of the imbalance, the skill/training of the therapist designing and administering the treatment, and the adherence to the exercise program prescribed.

As explained previously, the aim of VRT exercises is to encourage the brain and spinal cord to make up for any balance or equilibrium deficits that are present due to inner ear or central nervous system disease or abnormality. In other words, patients teach their vestibular system to do one of several things; adapt to stimuli that is presented, substitute other sensory pathways, or get used to the change in the vestibular signals sent to their brain such that they can manage their vestibular disorder and maintain a normal functioning life despite possible ongoing symptoms. In some cases, VRT can eliminate vestibular symptoms. Unfortunately, however, this is not always the case therefore minimizing symptoms or frequency of symptom recurrence is considered a successful outcome of VRT.

Research on VRT indicates that generally VRT exercises are effective in ameliorating many vestibular disorder symptoms and that the improvements can often be maintained for months following the therapy. The effectiveness of the therapy often heavily depends, however, on what exactly is causing the vestibular symptoms in the first place and the use of customized exercises rather than just a standard exercise protocol. VRT, however, is not universally effective for all vestibular problems. There are even some vestibular problems where exercise is not considered appropriate, therefore a proper diagnosis of the cause of symptoms is useful.

## **VRT Exercises**

If your physiotherapist feels that VRT is appropriate for you after your assessment is complete, they will prescribe a number of individualized exercises for you to regularly perform. These exercises will address your specific vestibular problem and the related symptoms. In addition, the exercises prescribed for you will focus on any everyday issues you are facing as a result of your symptoms. Some exercises will be performed with your physiotherapist at River Heights Physiotherapy and others will be taught to you such that you can complete them independently as part of a home exercise program. Medications to treat your symptoms can be an adjunct to VRT and should be discussed with your physician.

The types of exercises used in VRT can be divided into the following categories:

### ***Adaptation Exercises***

These exercises work to force the vestibulo-ocular reflex (VOR) to adapt to movement of the head. In a way it is encouraging the eye-ear-brain connection to 'reset' itself.

A commonly used protocol of exercises which are based on this principle of getting the VOR to adapt to progressively more advanced motions of the head are Cawthorne-Cooksey Exercises. This protocol of exercises has been around since WWII when two doctors, Terence Cawthorne & Harold Cooksey, noted that soldiers with balance disorders due to head injuries improved more quickly if they were forced to be active rather than bedridden. Examples include doing eye and head movements in sitting, and once these have been mastered these movements are then done while standing. Cawthorne-Cooksey Exercises are most effective when used in combination with other individualized vestibular exercises prescribed by your physiotherapist.

### ***Substitution Exercises***



The purpose of these exercises is to use visual cues and those coming from the joints and muscles, to make up for the loss in vestibular sensory cues. These exercises work to improve gaze stability and postural stability.

Gaze stability exercises improve one's vision while the head is moving. For example, a patient may be asked to focus on a target, keep it in focus, and then move their head side to side, all the while maintaining focus of the target. Specific exercises, which vary the speed of the head motion and the position of the head, such as those done when lying, sitting or walking, will also need to be trained.

An example of an exercise that challenges postural stability would be one where you are standing on a soft mat and trying to balance. To advance this exercise, the exercise would first be done with eyes open and then eyes closed.

### ***Habituation Exercises***

These exercises work to decrease the magnitude of the vestibular symptoms one feels by repetitively exposing the system to stimuli that bring on the symptoms. These exercises attempt to fatigue the vestibular response to the stimuli such that symptoms decrease over time. An example is putting your head down towards your knees in sitting and then back up. This exercise is repeated several times a day. The severity and duration of the dizziness felt after the exercise should be recorded.

### ***Compensation Exercises***

These types of VRT exercises encourage other systems and mechanisms associated with balance in the body to work harder in order to counteract the diseased vestibular system. They can include substitution type exercises but also include more generalized central nervous system based strategies. Often patients have already developed their own compensatory strategies by the time they have visited one of our physiotherapists. It is the job of your physiotherapist to help identify which strategies are in use and to assist you to use these strategies more effectively to manage your disease and symptoms.

### ***Canalith-Repositioning Maneuver or Exercises***

These exercises are used when otoconia (also called canalith) have settled in the semicircular canals and are causing vertigo and other symptoms. The treatment of BPPV is often successful with this type of VRT. Common maneuvers your physiotherapist may use are called the Epley Maneuver or the Semont Maneuver (also called the Liberatory maneuver.) Both maneuvers involve your physiotherapist holding your head into a certain position and then lying you down onto your back or side. If successful this motion dislodges the canalith and moves it into the inner ear area where it no longer causes symptoms. When these maneuvers work to treat BPPV, they often work quickly, even in just one treatment session.

Your physiotherapist may also prescribe a set of exercises for you to do at home, which is similar to the canalith-repositioning maneuver that they perform with you in the clinic. The most commonly used set of exercises are called Brandt-Daroff exercises. These home exercises are generally used to treat BPPV but may also be prescribed for other vestibular disorders.

### ***Machine-based Exercises***

There are several machines that have been developed to challenge the vestibular system and therefore may be used in VRT if available. Examples include virtual-reality type simulators and moveable standing platforms. The benefit of these types of exercises is that the parameters of the exercise can be objectively set

and measured, which allows objective improvement to also be measured. In addition, with some machines, once the program is set up, less direct therapist supervision may be required which allows more patient independence. With most types of VRT machines feedback is also provided, which enhances the learning ability. Home videos have also been developed for similar purposes.

### ***Gait Retraining***

These types of exercises work specifically on how you walk. Many people with vestibular issues develop an inefficient gait pattern. Your physiotherapist will assess your walking pattern and will prescribe specific exercises to address any issues you may have developed to compensate for your vestibular symptoms.

### ***General Exercise***

Many patients with a significant or chronic vestibular disorder avoid activity due to it bringing on their symptoms. These patients, particularly if of an elderly age, quickly become deconditioned. For these patients a general exercise regime aimed at improving cardiovascular health will be prescribed by your physiotherapist. The initial activity recommended is generally regular walking on even terrain, which should be done in a quiet and calm environment. As general cardiovascular health improves and normal walking is tolerated by the vestibular system then walking on uneven terrain and/or on a busy street where increased head movement is required can be initiated. Other general recreational activities such as golf, bowling, swimming or any other activity that you may enjoy can be discussed with your physiotherapist and added at their discretion.

## **Manual Neck Treatment**

Some patients who experience dizziness or balance issues have a concurrent orthopaedic problem with their neck, which is causing or adding to their symptoms. In some cases this may be the original problem and in other cases a problem in the neck may have developed due to an existing chronic vestibular problem which in turn causes decreased voluntary head and neck movement. In these cases your physiotherapist at River Heights Physiotherapy may also do some hands-on treatment for your neck in combination with the other VRT exercises described above.

## **Education**

Secondary injuries due to vestibular problems can easily occur due to frequent falls or near-miss falls. As part of your VRT your physiotherapist will ensure you are well educated regarding simple strategies that can minimize your risk for secondary injuries. For example, the use of a walking aid when you are tired or in a particularly busy environment, such as a grocery store, may be advised. Motion lights or night lights for during the evening hours or nighttime near the entry doors may be encouraged.

## **Conclusion**

VRT can be extremely useful to decrease or eliminate any vestibular symptoms you may be experiencing, which are present due to inner ear or central nervous system disease or abnormality. These exercises will show the best results if prescribed specifically for you by one of our physiotherapists at River Heights Physiotherapy.

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