

Vestibular Rehabilitation

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Continuing Education Activity

Dizziness is a common complaint among older adults, and the associated risk for falls and subsequent economic burden is significant. Vestibular hypofunction has an estimated prevalence of 35.4% within the United States (US) adult population, with dizziness and postural imbalance noted as primary complaints. Vestibular rehabilitation is an effective treatment of many disorders peripheral in origin and promising indications as a treatment for those of central origin as well, thus reducing symptoms and imbalance that often lead to falls. This activity reviews vestibular rehabilitation and highlights the role of the interprofessional team in evaluating, treating, and managing the care of patients with vestibular hypofunction.

Objectives:

- Describe the pathophysiology of vestibular hypofunction.
- Outline the common types of vestibular hypofunction.
- Review the most definitive tests for benign paroxysmal positional vertigo.
- Summarize the management considerations by interprofessional for patients with vestibular hypofunction.

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Introduction

Dizziness is a common complaint among the elderly, with as much as 30% of the population of older adults reporting dizziness with increased prevalence in women compared to men.

[1] Dizziness and associated postural imbalance have been shown to increase the risk of falls, with a resulting significant impact on quality of life, mortality, and the economic burden of associated costs.[1][2][3]

Vestibular hypofunction has an estimated prevalence of 35.4% within the United States (US) adult population, with dizziness and postural imbalance noted as primary complaints.

[4] Research has indicated moderate to strong evidence to support exercise-based rehabilitation of the vestibular system as an effective treatment in populations including unilateral and bilateral vestibular hypofunction. It has shown promising research in treatments for central vestibular hypofunction.[2][5][6][7]

Anatomy and Physiology

The vestibular system is a highly integrated system consisting of the vestibular apparatus within each inner ear functioning in conjunction with the central nervous system (CNS), ocular system,

and musculoskeletal system (postural control) to maintain balance.[5][8] The vestibular system functions to detect self-motion (head motion relative to time and space), with the subsequent primary contributions to postural stability being the vestibulospinal reflex (VSR) and vestibulo-ocular reflex (VOR).[6] These reflexes allow for the maintenance of visual stability with head motion and maintenance of postural control through muscle contractions, respectively.[5][7]

Motion is perceived within each vestibular apparatus, which consists of two otolithic organs (utricle and saccule) and three semicircular canals. Otolithic organs detect linear acceleration, while the semicircular canals (anterior, posterior, and horizontal) detect rotational (or angular) acceleration within their respective plane of orientation. Semicircular canals terminate at an ampulla on one end and the utricle at the other. Motion is detected within each canal via endolymph hydrodynamics and its influence on each ampullary cupula located at one end of each canal.[9]

The sensation of motion within each canal is translated by hair cells (or stereocilia), which extend into a gelatinous region known as the cupula. Displacement of the cupula (and thus hair cells) caused by movement of the endolymphatic fluid within the canal causes the sensory apparatus to discharge. The otolithic organs also depend on stereocilia for motion detection depending on location, with the saccule detecting vertical motion and the utricle detecting horizontal motion. Afferent nerves from the otoliths and semicircular canals transmit impulses to the vestibular nuclei and pontomedullary reticular formation via the vestibulocochlear nerve and disynaptic/polysynaptic pathways, where they are processed further with additional sensory input to provide orientation and modulate postural reflexes.[8]

The vestibular system works in conjunction with the visual and somatosensory systems to provide information to the CNS to orient the body relative to itself as well as the external environment. This information is highly integrated on multiple levels of the CNS, allowing the system to modify the output based on the reliability of the input received.[8] Vestibular hypofunction can have peripheral, central, or mixed origins, with treatment standards varying accordingly.[10]

Indications

Vestibular rehabilitation has been well documented as the cornerstone for peripheral vestibular hypofunction, benign paroxysmal positional vertigo (BPPV) treatment, and canalith repositioning for BPPV.[11][12] Further indications for completing vestibular rehabilitation exercises include patients with a stable vestibular lesion, central or mixed central and peripheral lesions, psychogenic vertigo, elderly individuals reporting dizziness, and vertigo with uncertain etiology.[6][10]

Preliminary research has demonstrated positive results for vestibular rehabilitation for head injury (concussions in particular) and central disorders such as cerebellar disorders and Parkinson disease), but further high-level research is needed to confirm the benefits of these preliminary studies.[4][6][13]

Contraindications

Unstable lesions are contraindicated for vestibular rehabilitation therapy, and those with ongoing labyrinthine pathology typically see little benefit from therapy. Patients with spontaneously occurring episodes of vertigo often see little benefit, as well as those who suffer from spontaneous disequilibrium.[10]

Vestibular suppressant medications (antiemetics, antidepressants, anxiolytics) should be held for 48 hours before testing as a relative contraindication.[14] Finally, due to the cervical range of motion required for many gaze-stabilization exercises and canalith repositioning maneuvers in BPPV treatment, individuals with cervical pathology or vascular pathologies are contraindicated.[9]

Equipment

Little equipment is needed for a field clinician to complete vestibular rehabilitation assessments and exercises. A thorough history is critical for understanding the underlying cause of a patient's symptoms. As such, access to a detailed history (from the patient or caregiver) is needed to guide treatment. A surface sturdy enough for a patient to lay on is necessary for BPPV assessment and treatment (plinth, bed, etc.), as well as a chair or surface for the patient to sit on during oculomotor assessment comfortably.[12]

Progression of gaze stabilization exercises requires increasing degrees of light and visually stimulating backgrounds with appropriate equipment. Initial vestibular treatment should be completed with a trained professional present to ensure the safety and maintenance of balance. Proper use of safety equipment, including parallel bars, gait belts, or tethers, should also be utilized to ensure the patient does not fall. If the patient is deemed able and safe to complete portions of exercises as part of the home exercise program, proper safety precautions should be maintained, including using a stable surface in front of them.[10]

A stretcher capable of tilting may also be indicated for patients requiring canalith repositioning techniques who are not able to tolerate head extension.[9] Frenzel goggles and M glasses can be useful tools for nystagmus assessment but are unnecessary.[12] Caloric testing can also be a beneficial diagnostic tool to differentiate between peripheral or central etiology, in which case equipment to complete caloric testing would be necessary.[14]

It is important to note that ancillary testing is primarily only needed if the diagnosis is questionable or the patient has not demonstrated adequate response to an appropriate course of treatment.[12]

Personnel

Physical therapists largely implement vestibular rehabilitation exercises, but the overall goal is for patients to return to activities of daily living (ADL); an occupational therapist may also utilize vestibular treatments with proper training.[4] One practitioner is typically sufficient to complete testing and treatment; however, due to the motions needed as well as to ensure safety in particularly frail patients or with obesity, additional personnel may be required circumstantially.[9]

Should additional ancillary testing be required or in the cases of significant underlying pathologies or surgical interventions, medical professionals, including neurologists, otolaryngologists, specialized vestibular centers, and appropriate surgical teams, would be necessary.[12][15]

Preparation

Clearance for all contraindications and verbal consent from the patient before completion of vestibular rehabilitation exercises is needed before treatment. Removal of eyeglasses is recommended as they can increase the sensation of vertigo during head oscillations required

during gaze exercises.[10]

Utilization of a questionnaire, many of which are available and should be used at the provider's discretion, is helpful to pinpoint not only ADLs affected (which will be useful for prescribing habituation exercises) but also in determining the intensity of vertigo and duration of symptoms (again, beneficial for exercise prescription and progression).[6][16]

Technique or Treatment

Vestibular rehabilitation therapy is most effective when origins are peripheral, but benefits for central disorders have been demonstrated, with further research needed to solidify these findings.[4][10][13] Peripheral vestibular hypofunction is primarily addressed through an exercise-based approach. Patients in the acute phase of injury may require medication management (including antiemetics and vestibular suppressants), though long-term medication use is ineffective for peripheral hypofunction.[4]

Central vestibular hypofunction, depending on the nature of origin, may require medication management throughout care.[12] It is known that gaze stability and dizziness are common difficulties following a cerebrovascular accident (CVA) and concussions. Still, continued research is needed to determine the validity of vestibular rehab as a treatment.[5][6][7][13] Vestibular exercises have also been shown to benefit patients with multiple sclerosis and Meniere disease following exacerbation in the remission stage.[17][18] Despite dizziness and oculomotor impairment being a known effect of many central disorders, the effectiveness of vestibular rehabilitation exercises for central vestibular disorders requires continued research to solidify results, though preliminary results are promising.[19][20]

Several oculomotor assessments exist and should be used in conjunction with the patient's history to differentiate peripheral versus central disorders. Central disorders typically display oculomotor disturbances, including difficulties with smoothing pursuit, saccades, gaze-holding, and nystagmus specific to central disorders.[21] The Head Impulse Test (HIT) is a measure used to assess the VOR integrity, with findings largely indicative of disorders peripheral in nature.[22]

Vestibular rehabilitation exercises fall into two main categories:

1. Exercises for canalith repositioning for BPPV, and
2. Exercises for vestibular hypofunction.[10]

BPPV screening largely includes Dix-Hallpike testing, as posterior canal involvement is the most common form, as well as side-lying testing for those who cannot tolerate neck extension (with tests also appropriate for anterior canal involvement, though this is rare).

The Dix-Hallpike maneuver is completed as follows:

1. Position the patient in long sitting with the head rotated 45 degrees toward the tested side.
2. Assist the patient into a supine position with the head held in 45 degrees rotation, and the neck extended 30 degrees (typically off the edge of the plinth).
3. Observation of nystagmus/reports of vertigo.[9]

The Sidelying test is completed as follows:

1. Position the patient seated with the head rotated 45 degrees away from the tested side.

2. Briskly assisted the patient into a side-lying position, with the side being tested in contact with the support surface.
3. Observation of nystagmus/reports of vertigo.[23]

The horizontal roll test is utilized to screen for horizontal canal involvement, with the testing procedure as follows:

1. Position the patient in a supine position with their head in midline and flexed to 30 degrees.
2. Examiner quickly rotates the patient's head 90 degrees to one side.
3. Observation of nystagmus is completed noting direction.
4. Examiner returns the head to the midline.
5. The examiner rotates the head 90 degrees to the opposite side as initially tested.
6. Observation of nystagmus is again completed, with the side eliciting the strongest symptoms being the affected side.[24]

Through test findings, including onset, direction, and duration of nystagmus, clinicians should be able to determine if the nature of the involvement is canalithiasis (otoconia displaced in semicircular canal) or cupulolithiasis (otoconia adhered to cupula), with canalithiasis thought to be more common. Canalithiasis demonstrates symptoms with a latency of onset as well as decreased severity with prolonged positioning due to the otolith moving and settling within the canal, whereas cupulolithiasis typically does not demonstrate latency in onset of symptoms nor a reduction of symptom severity with prolonged positioning due to the otoconia continually dragging the cupula down throughout positioning. Regarding horizontal canal involvement, depending on the direction in the nystagmus beats, the type of BPPV can be determined. Geotropic nystagmus, or nystagmus that beats toward the earth, corresponds with canalithiasis, while ageotropic nystagmus, or nystagmus that beats away from the earth, corresponds with cupulolithiasis.[24][25]

Treatment maneuvers for canalithiasis include the Epley maneuver for posterior canal involvement and the barbecue (or barrel) roll, and the Gufoni (sometimes referred to as Appiani) maneuver for horizontal canal involvement, with the roll maneuver having reduced use in certain demographics due to advanced positioning requirements.

The positioning for the Epley maneuver is as follows:

1. Position the patient in long sitting with the head rotated 45 degrees toward the affected side.
2. Assist the patient into a supine position with their head held in 45 degrees rotation and neck extended 30 degrees (typically off the edge of the plinth).
3. Hold this position for 1 to 2 minutes.
4. While maintaining extension, assist the patient in rotating their head 90 degrees to the opposite side.
5. Assist the patient in continuing to roll their body into side-lying on the side opposite of their affected ear, with their head rotated an additional 90 degrees (facing down).

6. Hold this position for 1 to 2 minutes.
7. Assist the patient in the seated position.[24]

The positioning for the Gufoni maneuver is as follows:

1. Position the patient in a sitting position.
2. Assist the patient in quickly lying on the unaffected side.
3. Hold this position for 1 minute.
4. Quickly rotate the patient's head 45 degrees down.
5. Hold this position for 2 minutes.
6. Slowly assist the patient into the sitting position.[25]

Treatment maneuvers for cupulolithiasis include the Semont liberatory maneuver for posterior canal involvement and various treatments for horizontal canal involvement, including the new Gufoni maneuver, Zuma maneuver, head shaking maneuver, and modified Semont maneuver, with horizontal cupulolithiasis being less prevalent and thus the less established treatment protocol. Anterior canal involvement is considered rare, and as such, data on treatment maneuvers is lacking, some of which include the reverse Eply or Yacovino maneuvers. It should be noted that in treating cupulolithiasis, the adhered otoconia should be detached from the cupula and thus converted into canalolithiasis with the follow-up canalolithiasis maneuver required to transport the otoconia back to the utricle successfully.[9][24][25]

Exercises for vestibular hypofunction include two subcategories: gaze stabilization exercises and habituation exercises. Gaze stabilization exercises include adaptation and substitution exercises. Recall that the vestibulo-ocular reflex allows the body to maintain focus on a target while the head is in motion.[7] Adaptation refers to the long-term change in the VOR (resetting the gain), which will reduce the severity of symptoms, thus normalizing gaze and postural stability.[4]

The gain refers to the ratio of head-to-eye movement that allows a target to stay stable in the field of vision, which should be 1 to 1.[26] To achieve this, exercises must include head motion while the gaze is fixed on a target. Whereas the goal of adaptation exercises is to reset the gain, substitution exercises focus on substituting the function of additional systems to compensate for the loss of vestibular function. These substitution techniques can include eye movements (such as smooth pursuit) or the use of an assistive device to facilitate additional somatosensory input, thus increasing stability.[10]

Habituation exercises involve repeated exposure to noxious stimuli to decrease symptoms related to stimuli over time. It is important to note that habituation exercises must be specific to patient symptoms, depending on the type, intensity, and direction of provocative stimuli. Through repeated exposure to these stimuli, the central nervous system can undergo compensation, and relief from noxious symptoms will follow. This is potentially achievable through therapy-driven exercises incorporating specific noxious stimuli and the use of technology (virtual reality immersion, optokinetic discs, videos of busy environments, etc.).

Vestibular rehab also encompasses walking for endurance and exercises to improve gait and overall balance. These exercises are intended to facilitate improvement in somatosensory and visual systems to substitute for missing or injured vestibular functions. This can be achieved

through a variety of methods, including the use of foam or uneven surfaces during gait and functional tasks, decreasing base of support (such as Romberg or tandem stance, narrow stance, or single leg stance), perturbations/weight shifting to facilitate balance recovery, and balance activities under changing visual stimuli (such as a busy background or eyes closed). General conditioning is often included in vestibular rehab as well because many individuals avoid provoking motion and thus become deconditioned. Though a critical component to address a possible undesirable side effect of vestibular hypofunction, general conditioning alone has not been proven beneficial to those with vestibular hypofunction.[4][10]

Complications

Vestibular rehabilitation exercises have few complications, with associated nausea or symptom increase being the most prevalent. Exercises can be modified through duration and intensity, and sometimes antiemetic medication may be necessary in conjunction with exercises in the case of prolonged vertigo following vestibular exercises. In rare cases, those undergoing canalith repositioning for BPPV can suffer cervical and vascular injury if underlying pathologies are present, which is why a thorough cervical screen and history review are imperative.[9]

Unresolved vestibular hypofunction and failure to habituate the vestibular system can lead to compensatory strategies, namely, reducing cervical mobility to avoid provocative motions. This reduction in mobility can lead to long-term changes in the cervical spine and overall deconditioning due to a lack of regular mobility.[4][10]

Clinical Significance

Dizziness and associated postural imbalance have been shown to increase the risk of falling and fear of falling (which is a strong predictor of multiple falls).[2] Dizziness alone is a large economic burden on the US healthcare system, accounting for approximately 4%, or \$4 billion, annually within the US.[1]

Falls are the leading cause of injury-related emergency room visits, hospital admissions, and accidental deaths in the elderly population, with associated costs estimated at \$754 million in 2015 and are expected to climb within the next 20 years.[2][3][27]

With canalith repositioning being as much as 89% effective following a single treatment and vestibular rehabilitation exercise being accepted as an effective treatment for peripheral vestibular hypofunction based on multiple high-level studies as well as a promising potential treatment of central causes of hypofunction, the potential effect to reduce this burden should be considered.[4][5][6][7][9]

Enhancing Healthcare Team Outcomes

Interprofessional collaboration, including clinicians, mid-level practitioners, nurses, and therapists, is imperative to the effectiveness of vestibular rehabilitation due to the complexity in nature and requirements for diagnosis and treatment, as well as the varying levels of treatment and required providers needed to accomplish these techniques (exercises, medication administration, surgical intervention, etc.).[28] Interprofessional communication and collaboration will help drive better outcomes in vestibular rehabilitation. [Level 5]

Collaboration is also necessary to reduce costly procedures that neither aid in diagnostic measures nor benefit rehabilitation outcomes for the patient. Excessive diagnostic testing for vestibular patients has been demonstrated despite a thorough history combined with diagnostic

maneuvers to be more effective in diagnoses (especially with BPPV). Medications are frequently chosen as the first course of treatment despite repositioning techniques and exercises being the most effective treatment for peripheral vestibular hypofunction and BPPV.[4][29] Meclizine and vestibulo-suppressants are still widely used despite being no better than placebo, and no improvement in balance was noted.[11][29]

It is crucial not only for the care of the patient but also for a reduction in costly and unnecessary testing that practitioners can identify possible vestibular pathologies and either complete diagnostic testing or refer to medical professionals (vestibular specialists, physical therapists, occupational therapists) who can treat the patient and address their functional deficits. The future of vestibular rehabilitation also rests on collaboration, with promising research on the effectiveness of web-based programs to supplement face-to-face provider treatment while still meeting the patient's needs.[11]

Nursing, Allied Health, and Interprofessional Team Interventions

Surgery is rarely indicated but may be required based on the underlying pathology of vestibular dysfunction, such as perilymphatic fistula repair or acoustic neuroma (vestibular schwannoma) removal. Ablative surgery is also sometimes completed in cases where recurrent vertigo cannot be controlled by less invasive means to convert fluctuating hypofunction into stable hypofunction to allow for compensation through other systems.[4] These types of surgeries are typically seen in cases of BPPV and Meniere disease. They can include singular nerve section and occlusion surgery as well as saccotomy, cochleosacculotomy, neurectomy of the vestibular nerve, and labyrinthectomy, respectively.[15]

As mentioned previously, medication administration is sometimes indicated (though discouraged for long-term use in most cases) and would require proper administration and management. Medications can be used to reduce associated symptoms (vestibular suppressants, such as valium or meclizine) and ototoxic medications used for ablative purposes (particularly gentamicin).[4] [12] It is important for prescribing practitioners and treating practitioners to review medications with patients and identify if a patient is on a drug that could have ototoxic or vestibular suppressant side effects as part of the history review.[4]

Recall that a thorough medical history is imperative to differentiate the cause of “dizziness” that is often considered vestibular but could be vascular, cardiac, medication-induced, or neurological in nature.[28] Though many diagnostic tests are overutilized, it is necessary to rule out infarctions when considered, especially in the elderly, as this demographic is at greater risk of an infarct.[29]

Nursing, Allied Health, and Interprofessional Team Monitoring

Ongoing monitoring of medications (in particular, weaning off medications for symptom reduction as rehabilitation progresses) is required by an administering physician with the assistance of the treating practitioner, depending on patient progress. Collaboration between referring physicians and therapy services is also indicated to monitor patient progression and to seek alternative treatments should conservative treatments fail.[28]

Collaboration is also crucial in adherence to vestibular rehab, as it has been shown that compliance, as well as the ability to perform techniques, is poor without facilitation. Medical and technology professionals are working to improve web-based programs to facilitate improved home exercise programs in the future but are currently in preliminary stages.[11]

Review Questions

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