Balance and Vestibular Rehabilitation after Stroke

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Disclosure

➢ We have no disclosures
Objectives

- Outline the conditions that benefit from vestibular and balance rehabilitation
- Review current research that discusses individuals that would benefit from this type of therapy
- Identify goals and benefits of vestibular rehabilitation

Importance of the Topic

- Imbalance and dizzy complaints common
- Chronic impaired balance and dizziness cause decreased safety, reduced independence, and increased disability
- Impaired balance related falls:
  - Hip fractures
  - Rib fractures
  - Compression fractures
  - Shoulder/arm injuries
  - Head injuries
  - Death
Vestibular System

- Maintains equilibrium or balance by detecting rotational and linear movements
- Integration of:
  - Visual information – used to provide stable visual image to allow for making adjustments to posture for balance
  - Sensory information – afferent input from body regarding position and location of arms, legs, trunk, and head in space
  - Vestibular information – vestibular organ in temporal bone that sends information about movement of the head

Vestibular Organ

- 3 perpendicular semicircular canals – rotation
  - Horizontal
  - Superior
  - Posterior
- 2 otolith organs – linear
  - Utricle
  - Saccule
Vestibular Organ

- Rotational movement
  - Vestibular hair cells in ampulla of each canal that sense fluid movement around circular canal
- Linear movement
  - Otolith mass made of crystal and glycoprotein that move over hair cells to detect shift

Transduction of Signal

- Hair cells $\rightarrow$ afferent vestibular nerve fiber (via Vestibulocochlear nerve CN VIII) $\rightarrow$ Vestibular nuclei of medulla
- Vestibular nuclei relays the signal to multiple regions:
  - Spinal cord (via vestibulospinal tract) for posture control and extensor muscle tone
  - Brainstem and cerebellum for management of equilibrium
  - Extraocular muscles for coordination of head and eye movements
Parts of the Cerebellum

- **Vestibulocerebellum**
  - Vestibular input and control balance and eye movements
- **Spinocerebellum**
  - Spinal cord input and controls synergy of movements
- **Pontocerebellum**
  - Cerebral input, via pontine nuclei, and controls the planning and initiation of movements

Disorders of the Cerebellum

- Control rate, range, force, and direction of movements – overall synergy
- Damage results in lack of coordination such as:
  - Delayed onset of movement
  - Over or under shooting targets
  - Dysdiadochokinesia – unable to do rapid alternating movements
  - Intention tremor – increase tremor at the end of movement
  - Rebound phenomenon – unable to stop movement when resistance removed
### Conditions Associated with Vestibular Dysfunction

- **Peripheral**
  - Peripheral vestibulopathy
  - Benign positional vertigo
  - Vestibulotoxic drug-induced vertigo
  - Meniere’s disease
  - Others such as local bacterial infection, genetic anomalies, otosclerosis, etc.

<table>
<thead>
<tr>
<th>Conditions Associated with Vestibular Dysfunction</th>
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</thead>
<tbody>
<tr>
<td><strong>Systemic</strong></td>
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<tr>
<td>- Drugs – anticonvulsants, antihypertensives, alcohol, analgesics, sedative hypnotics, etc.</td>
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<td>- Hypotension, presyncope</td>
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<td>- Infectious disease</td>
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<td>- Endocrine disease</td>
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<td>- Vasculitis</td>
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<tr>
<td>- Others such as polycythemia, anemia, sarcoidosis, systemic toxins, granulomatous disease, etc.</td>
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Conditions Associated with Vestibular Dysfunction

- Central
  - Brainstem stroke
  - Demyelinating disease
  - Cerebellopontine angle tumor – ex. acoustic neuroma, metastatic tumor
  - Cranial neuropathy - CN VIII
  - Intrinsic brainstem lesion
  - Posterior fossa lesion
  - Seizure disorders
  - Heredofamilial disease – spinocerebellar degenerations: Friedreich’s ataxia, olivopontocerebellar atrophy

Central Vestibular Dysfunction

- Disruption to “vertobrobasilar system” which includes:
  - Brainstem
  - Cerebellum
  - Occipital lobe
  - Vertebral arteries
  - Basilar artery
Classic Cerebellar Stroke Symptoms

- Difficulty with eye movements
- Ataxic movements
- Dizziness
- Nausea and vomiting
Dizziness, Vertigo, and Imbalance Presentation in the ER

- Estimated 7.5 million seen in primary care and emergency room for primary complaint of “vertigo”, “dizziness”, and “imbalance”
- 3.2% diagnosed with stroke/TIA
- 0.7% of those diagnosed with stroke/TIA had isolated vertigo and dizziness without other neurological findings

Other Stroke Causes of Dizziness and Imbalance

- Neglect syndromes
- Hemiparesis
  - Pure motor or sensory
  - Motor and sensory
- Visual impairment
  - Diplopia
  - Hemianopsia
Balance Difficulty Post Stroke

- Pure vestibular impairment – rare
- Multifactorial – majority
  - Weakness
  - Sensory impairment
  - Visual impairment
  - Perceptual impairment / Neglect syndrome
  - Central vestibular impairment

Examination After Stroke

- Evaluate
  - Nystagmus
  - Central oculomotor function
  - Vestibulo-ocular reflex battery
  - Long tract signs
  - Dysarthria
  - Dysphagia
  - Hemiparesis
  - Coordination
  - Visual perception
  - Posture
  - Gait
Outcomes with Treatment of Isolated Cerebellar Strokes

- Represent small percentage of all strokes
- Study of 58 patients
  - 49 ischemic strokes
  - 9 hemorrhagic strokes

### Functional Independence Measure

**FIM™ instrument**

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<thead>
<tr>
<th>Activity</th>
<th>No Helper</th>
<th>Helper</th>
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</thead>
<tbody>
<tr>
<td>ADLs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
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</tbody>
</table>

**Legend**

- 100 = Independent
- 90 = Maximal Assistance
- 60 = Minimum Assistance
- 0 = Total Assistance

**Note:** Ratings above 60 reflect a patient who is independent or minimally dependent in each item. The maximum possible score is 126, with a minimum possible score of 0.
Outcomes with Treatment of Cerebellar Strokes

- After rehabilitation:
  - 80% FIM score > 72 (equal to minimal to no assistance with all tasks)
  - 66% FIM score > 90 (equal to supervision to functionally independent with all tasks)
- Hemorrhagic more impaired than ischemic stroke at admission and discharge
- Higher functional independence in strokes with vertigo, ataxia, vomiting, and headache without record of hemiparesis and change in consciousness

Effectiveness of Balance Rehab Program with Visual Cues After Stroke

- Participants with hemiparesis and at least 12 months post stroke
- Isolated single stroke
- No history of vestibular dysfunction or vertigo prior to stroke
- Underwent platform training for correcting balance and postural asymmetry
- Exercises program – one group with vision deprivation and second group with vision allowed
Effectiveness of Balance Rehab Program with Visual Cues After Stroke

- All improved significantly
  - More improvement with vision deprivation than with vision allowed with exercises
  - Thought process is that increased need for somatosensory and vestibular information to make up for lack of vision during exercises caused increase in improvement, but both groups improved

Techniques to Treat Balance and Vestibular Dysfunction

- Physical therapy
- Occupational therapy
- Visual rehabilitation
- Vestibular rehabilitation therapy
- Physician evaluation for reversible causes of dysfunction, such as medication side effect or hydration status.
Definition

Vestibular Rehabilitation Therapy (VRT) is an area of physical therapy that uses specialized exercises to retrain vestibular system in order to improve gaze stability and reduce symptoms of dizziness/imbalance.

Vestibular Rehabilitation Therapy (VRT)

If the brain cannot rely on the information it receives from the vestibular system, a person’s ability to maintain posture and coordinate balance can become overly dependent on vision or on proprioception. This can lead to developing new patterns of movement to compensate for the change.
Vestibular Rehabilitation Therapy (VRT)

- VRT exercises involve head, body and eye movements
- Head movements are necessary in stimulating and retraining the vestibular system.

Goals of VRT

- Retrain the brain to recognize and process signals from the vestibular system in coordination with vision and proprioception.
- Decrease dizziness and visual symptoms
- Decrease risk of falls
- Improve patients’ independence and function
Who would benefit?

Patients whose common clinical manifestations may include:

a) subjective complaints often lasting for months or years
   - Vertigo
   - Nausea
   - Dysequilibrium

b) symptoms that are associated with movements of head or body, and/or increased visual stimulation.

c) history of falls

d) difficulty walking or unsteady gait
Physical Therapy Evaluation

- Medical History/Symptoms assessment
  - Type and intensity of sx’s, h/o falls, effect on ADLS
  - DHI
- Oculomotor assessment
  - Smooth pursuit, Saccades, Head Thrust, VOR, VOR cancellation, Head Shake, Static and dynamic visual acuity tests.
- Balance assessment
  - Static and dynamic
  - Berg balance/Tinetti/DGI/FGA/TUG
- Gait assessment
- Neuromuscular / Musculoskeletal assessment

Therapeutic Interventions

- Exercises:
  - Habituation
  - Adaptation
  - Substitution
- Gait training
- Balance training
- Others as needed, e.g., strength, flexibility
Therapeutic Interventions: Equipment

- Infrared video goggles for visual motor assessment
- Visual target, e.g., business card with letter drawn (E)
- Varied density soft surfaces: foam (Airex), Dyna disc, Aeromat
- Overhead support harness system (for safety with ambulation activities)
- Dynavision D2 (training visual and motor function)

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Therapeutic Interventions: Equipment

- NeuroCom Balance Master:
  Tests the somatosensory, visual and vestibular systems to help detect sensory deficits in balance and postural control. It can also be used to perform sensory specific exercises to improve deficient areas.
Equipment

NeuroCom Smart Equi Test Balance Master

Summary

Vestibular Physical Therapy

- Compliance with HEP is crucial
- In central impairments VRT may take longer time and progress may be limited
- VRT improves patients functional mobility and safety
References and Resources

7. Swan L, Yorke A. An Introduction to Vestibular Rehabilitation.
9. www.vestibular.org (Vestibular Disorders Association)
10. www.resourcesonbalance.com

References and Resources