

Vestibular Examination & Rehabilitation

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Vestibular System Function

- Provides information concerning gravity, rotation and acceleration
- Serves as a reference for the somatosensory & visual systems
- Contributes to integration of arousal, conscious awareness of the body via connections with vestibular cortex, thalamus and reticular formation
- Allows for:
 - gaze & postural stability
 - sense of orientation
 - detection of linear & angular acceleration

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Vestibular Anatomy

- Peripheral sensory apparatus
 - detects & relays information about head angular & linear velocity to central processing system
 - orients the head with respect to gravity
- Central processing system
 - processes information in conjunction with other sensory inputs for position and movement of head in space
- Motor output system
 - generates compensatory eye movements and compensatory body movements during head & postural adjustments

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Ascending Pathways

- Vestibular nerve
- Vestibular nuclei
- Cerebellum
- Oculomotor complex
 - Cranial nerves 3, 4, and 6
 - Along with vestibulospinal reflexes coordinate head and eye movements

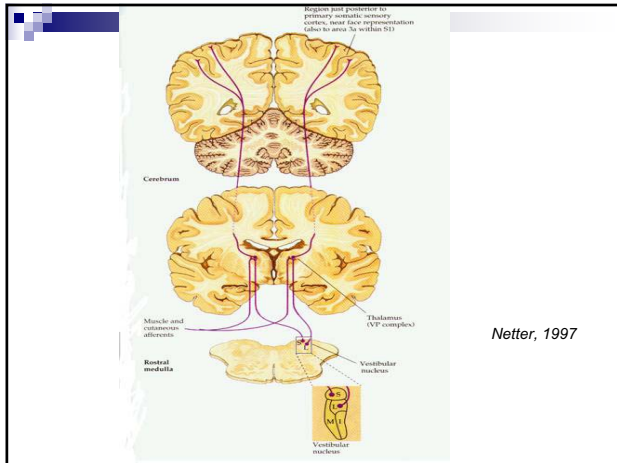
Cerebellum

- Monitors vestibular performance
- Readjusts central vestibular processing of static & dynamic postural activity
- Modulation of VOR
- Inhibitory drive of VOR

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Relay Centers

- Thalamus
 - Connection with vestibular cortex and reticular formation → arousal and conscious awareness of body; discrimination between self movement vs. that of the environment
- Vestibular Cortex
 - Junction of parietal and insular lobe
 - Target for afferents along with the cerebellum
 - Both process vestibular information with somatosensory and visual input



Descending Pathways

- Provide motor output from the vestibular system to:
 - Extraocular muscles (*part of VOR*)
 - Spinal cord & skeletal muscles (*generate antigravity postural activity to cervical, trunk & lower extremity muscles*)
- Response to changing head position with respect to gravity (*righting, equilibrium responses*)

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Vestibulospinal Reflex (VSR)

- Generates compensatory body movement to maintain head and postural stability, thereby preventing falls

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Principles of the Vestibular System

- Tonic firing rate
- Vestibular Ocular Reflex
- Push-Pull mechanism
- Inhibitory cutoff
- Velocity storage system

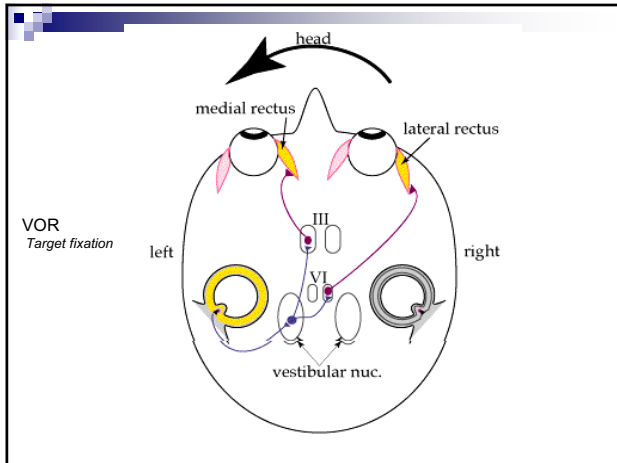
Compensatory Eye Movements

- Vestibular Ocular Reflex (VOR)
- Optokinetic reflex
- Smooth pursuit reflex, saccades, vergence
- Neck reflexes
 - All combine to stabilize object on the same area of the retina = visual stability

Vestibular-Ocular Reflex (VOR)

- Causes eyes to move in the opposite direction to head movement
- Speed of the eye movement equals that of the head movement
- Allows objects to remain in focus during head movements

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Vestibular Processing Gain

- Keeps eye still in space while head is moving
- Ratio of eye movement to head movement (*equals 1*)

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Vestibular Processing Velocity Storage Mechanism

- Perseveration of neural firing in the vestibular nerve by the brainstem after stimulation of SCC to increase time constant
 - SCC respond by producing an exponentially decaying change in neural firing to sustained head movement
- Otolith & somatosensory input also drive mechanism

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Vestibular Dysfunction

Injury Location

- Inner ear
- Vestibular nerve
- Central structures and pathways

Vestibular Pathophysiology

- Disorders of tone & or gain (vertigo; movement-induced vertigo)
- Vestibular nerve/nuclei give abnormal sensory information
- Tone automatically recovers in a few days; does not need visual input
- Compensation for reduced gain depends on visual images; takes month to years to complete; high speeds & accelerations may never be complete
- Nystagmus usually transient sign of vestibular lesion; movement-induced symptoms can be chronic

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VOR Dysfunction

- Direction of gaze will shift with the head movement
- Cause degradation of the visual image
- In severe cases, visual world will move with each head movement (vertigo)

Vertigo

- An asymmetrical firing of the two vestibular systems
- Gives an illusion of spinning, movement
- Indicative of any one or combination of causes (*acute UVH, BPPV, brainstem lesion, vascular hypotension...*)

Oscillopsia

- Visual illusion of oscillating movement of stationary objects
- Can arise with lesions of peripheral or central vestibular systems
- Indicative of diminished VOR gain
 - motion of images on fovea
 - diminished visual acuity



Vestibular Dysfunction Demographics

- Vestibular disorders manifested by vertigo are a significant health problem, secondary only to LBP
- NIH study estimates that 40% of the population over the age of 40 will experience a dizziness disorder during their lifetime

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Demographics

- Falls most common cause of TBI
- TBI accounted for 46% of fatal falls in older adults (CDC, 2008)
- Dizziness most common symptom of TBI, occurring initially in 98%

Dizzy Patient Presentation: Unexplained or new onset of symptoms

- Medical referral
 - Constant vertigo
 - Lateral pulsion
 - Facial asymmetry
 - Speech & or swallowing difficulties
 - Oculomotor dysfunction
 - Vertical nystagmus
 - Severe headaches
 - Recurrent falls
 - Unilateral hearing loss, tinnitus, fullness, ear pain

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Bilateral Vestibular Loss

- VOR cannot be recalibrated
- Compensatory mechanisms are used

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Compensatory Mechanisms

- Sensory substitution
- Motor substitution
- Predictive & anticipatory strategies

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Central Vestibular Disorders

- Vascular
 - Wallenberg's Syndrome
 - Head Injury
 - Cerebellar Infarct
- Postconcussive Syndrome
- Demyelinating Disease
- Congenital

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Traumatic Brain Injury

- 30-65% suffer symptoms of vestibular pathology during recovery
- Mechanisms of injury:
 - concussion
 - fractures
 - intracranial pressure & hemorrhagic lesions
 - central vestibular lesions

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Central Vestibular Disorders

- Clinical classification according to three major planes of action of the VOR
- Determined by ocular motor, postural, & perceptual signs

Herdman, 2000

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YAW PLANE SIGNS

(lateral medulla including root entry zone of VIII and/or vestibular nuclei)

- Horizontal nystagmus
- Past pointing
- Rotational & lateral body falls
- Horizontal deviation of perceived straight-ahead

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ROLL PLANE SIGNS

(ipsiversive at pontomedullary level; contraversive at pontomesencephalic level)

- Torsional nystagmus
- Skew deviation
- Ocular torsion
- Tilts of head, body & perceived vertical

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PITCH PLANE SIGNS

(bilateral lesions or bilateral dysfunction of the flocculus)

- Upbeat/downbeat nystagmus
- Forward/backward tilts & falls
- Vertical deviations of perceived straight-ahead

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ARIETINSULAR VESTIBULAR CORTEX

- Main sensorimotor integration center
- Dysfunctions:
 - vestibular seizures
 - signs
 - tilt of perceived vertical
 - lateropulsion ("pusher")
 - rare rotational vertigo

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Vestibular Assessment

- Knowledge of vestibular tests
- Determine unilateral or bilateral dysfunction
- Positional disturbances
- Postural stability deficits
- Functional deficits
- Other systems

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Assessment of the Patient after Whiplash/Concussion

History

- Medical History
- Subjective History
- Fall History
- Functional History

Clinical Examination

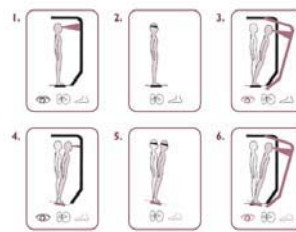
- Upper quarter screen
- Cervical spine instability tests
- Oculomotor testing
- Ambulation
- Functional gait assessment
- Static balance
- Dynamic balance
- Motion sensitivity
- Fall risk
- Activity level
- Balance confidence
- Quality of life

Laboratory Vestibular Function Tests

- Caloric test
- Rotary Chair test
- Posturography

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Sensory Organization Test (SOT)



Sensory Organization Test

Provides sensory conflicts

Postural sway is measured during 6 different sensory conditions

Performance patterns may guide expectations for certain diagnoses



Results of Vestibular Function Tests

- Complete vs. incomplete loss
- Peripheral vs. central dysfunction
- Direct patient management
- Assist in outcome prediction

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Blunt Trauma Dizziness

- Positional Vertigo
- Exertional Dizziness
- Migraine Associated Dizziness
- Spatial Disorientation/dysequilibrium

Hoffer ME, 2004 & 2007

Normal Structure Function vs. Impairment

- Vestibular hypofunction symptoms emerge from functional deficits in:
 - Vestibulo-ocular system
 - Vestibulospinal system
 - Sensory mismatch
 - Physical deconditioning

Herdman, 2007

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Loss of VOR/VSR

- Poor VOR
 - Difficulty seeing clearly during head movements, more so with unpredictable ones
- Poor VST
 - Results in diminished confidence in balance
 - Decreased gait speed
 - Increased risk for falling

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Differentiation Between Peripheral & Central Causes of Vertigo

| | <u>Peripheral</u> | <u>Central</u> |
|-----------------|-------------------|----------------|
| Nausea | severe | moderate |
| Imbalance | mild | severe |
| Hearing Loss | common | rare |
| Oscillopsia | mild | severe |
| Neurologic Sym. | rare | common |
| Compensation | rapid | slow |

Furman JM, Whitney SL, 2000

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Peripheral Vestibular Disorders

- Vestibular Neuronitis
- Labyrinthitis
- Meniere's Disease
- Acoustic Neuroma
- Perilymph Fistula
- Benign Paroxysmal Positional Vertigo (BPPV)

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Vestibular Clinical Exam

- Spontaneous nystagmus (*imbalance in tone*)
- Postural instability (*abnormal tone & gain, proprioceptive loss*)
- VOR gain (*maintained fixation, dynamic visual acuity*)
- Head shaking (*compensated UVL, not necessarily PVL*)
- Calorics; pressure sensitivity
- Hyperventilation (*anxiety, acoustic neuroma*)

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Nystagmus

- Primary diagnostic indicator in identifying vestibular lesions
- Physiologic nystagmus
 - vestibular, visual, extreme lateral gaze
- Pathologic nystagmus
 - spontaneous, positional, gaze evoked

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Dizziness Handicap Inventory

- Three subscales
 - function
 - emotion
 - physical aspects
- Scoring
 - Yes 4 pts.
 - Sometimes 2 pts.
 - No 0 pts.
- Excellent test-retest reliability

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Hallpike-Dix Maneuver

- Gold standard used to check for the presence of benign paroxysmal positional vertigo (BPPV)
- Nystagmus induced by this test is an objective measurement from which we can determine SCC dysfunction and assess a response to treatment

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Contraindications to Dix-Hallpike Test

- History of cervical surgery
- Recent cervical trauma
- Severe rheumatoid arthritis
- Atlantoaxial and occipitoatlantal instability
- Cervical myelopathy or radiculopathy
- Chiari malformation

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Benign Paroxysmal Positional Vertigo (BPPV)

- Signs and symptoms
 - Sudden, severe attacks of vertigo precipitated by certain head positions & movements
 - e.g., rolling over, neck extension, bending forward
 - Lightheadedness; nausea
 - Anxiety
 - Avoids movement
 - Direction & duration of nystagmus differentiates between BPPV & a central vestibular lesion (CVL)

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Diagnosis of BPPV

5 criteria crucial in diagnosis (Hallpike-Dix Test)

1. Torsional/linear-rotary nystagmus; reproduced by provocative positioning with affected ear down
2. Nystagmus of 1-5 sec. latency
3. Nystagmus extinguishes
 1. Canalithiasis: < 60 sec.
 2. Cupulolithiasis: > 60 sec.
4. Reversal of nystagmus direction on returning to upright position
5. Response diminishes with repetition of maneuver (*fatigability*)

Massoud, 1996

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BPPV Cupulolithiasis

- Debris, probably fragments of otoconia from the utricle, adhere to the cupula
- Treatment
 - Brandt-Daroff habituation exercises
 - Semont liberatory maneuver

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BPPV Canalithiasis

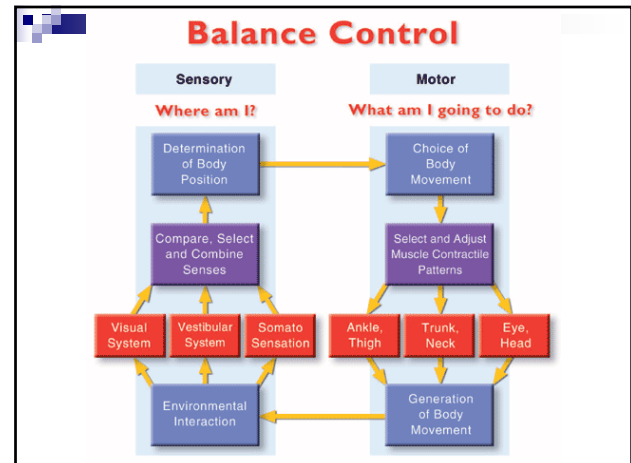
- Debris floating freely in the endolymph in the long arm of the posterior SCC
- Treatment
 - Canalith repositioning maneuver (CRM)
 - 84-90% remission rate

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Balance

- Can be viewed as a motor skill that emerges from the interaction of multiple systems
- These systems are organized to meet functional task goals & are constrained by the type of environment
- Balance, like any skill, can improve with practice

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Systems Approach to Examination

- Examination of balance & mobility using a variety of tests & measurements to document functional abilities, determine underlying sensory, motor, & cognitive impairments contributing to functional disabilities

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Clinical Test of Sensory Interaction In Balance (CTSIB)

- Assesses pattern of sensory dependence for balance from timed stance tests during distortion of sensory environment
- Sway and movement strategies are identified

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Berg Balance Scale

- Performance -orientated balance assessment
- Interpretation:
 - > 45/56 highly specific (96%) for nonfallers
 - subjects who fell most frequently were those closer to cut off
- Correlates with other balance tests

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Walking Speed: The Sixth Vital Sign

Fritz S, 2009

- Complex functional activity that is a reliable, sensitive and specific measure
- Can be used as a predictor of future
 - Health status
 - Functional decline
 - Falls
 - Hospitalization
 - Discharge location
 - Mortality

Habitual Gait Speed (HGS)

- HGS is used to assess mobility, dynamic balance and LE power
- Gait velocity is a measure of how well multiple systems are integrated into lower limb function
- Gait speeds of <1.8 feet/sec are reported as a higher risk for recurrent falls
- Gait speed cut off of <3 feet/sec as high risk for incident major health related events; hospitalization and death
- Impairments in mobility, balance, and strength required for normal gait speed can be used as signs of disease, frailty, and preclinical disability

Bohannon, 1997; Cesari, 2005; Guralnik, 2000; Van Swearingen, 1998

Dynamic Gait Index

- Measures the ability to adapt gait to changes in task demands
- Score <20/24 related to fall history in community-dwelling older adults, people with central and peripheral vestibular dysfunction
- Concurrent validity with the Berg Balance Scale
- Correlation with Activities-specific Balance Confidence Scale (ABC)

Whitney, 2003; Powell, 1995

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Functional Gait Assessment (FGA)

- Modified version of DGI used to assess postural stability
- Developed to increase sensitivity to minor changes in gait stability; issue with a ceiling effect seen in the DGI in patients with vestibular deficits
- Contains 10 items, 3 new (*gait with narrow BOS, walking backwards, walking with eyes closed*)

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Intervention

Therapeutic Intervention Objectives

- Change impairments
- Improve functional performance
- Improve capacity to adapt performance to changing task & environmental demands

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Mechanism of Recovery Compensation

- Results from changes in CNS
 - rebalancing of tonic activity within vestibular nuclei (*spontaneous recovery*)
 - recovery of VOR (*vestibular adaptation*)
 - habituation (*progressive decline in response to same stimulus*)
 - alternative strategies/substitution; in complete loss of vestibular function
- Enhanced by active movements & processing of visual, vestibular, & somatosensory stimuli

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Compensatory Mechanisms

- Substitution or modification of saccades
- Increase gain of the cervico-ocular reflex (COR)
- Use of central preprogramming in eye movements
- Enhancement of smooth pursuit movement

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Result of Early Intervention

- Gain returns quicker
- Increased function
- Decreased gait ataxia
- Decreased perception of dysequilibrium

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Goals of Vestibular Rehabilitation

- Diminish dysequilibrium, sense of being “off balance”
- Decrease risk of falling e.g., improve ability to see clearly with head movement
- Decreased social isolation
- Motivate patient to comply with activity program

Herdman, 2001

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Vestibular Exercise Program Objectives

- Complement CNS natural compensation
 - diminish dizziness & vertigo
 - enhance gaze stabilization
 - enhance postural stability in static & dynamic situations
- Increase overall functional activities
- Patient education

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Vestibular Program Components

- Gaze stabilization exercises to retrain VOR function
- Balance retraining to retrain VSR function
- Cardiovascular & strengthening exercises to increase activity & fitness level
- Habituation or canal repositioning maneuvers as indicated

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Interventions: Reduced Vestibular Function

- Retrain VOR & VSR function
 - adaptation (*vestibular system ability to adapt to changes in sensory information*)
 - substitution
 - relies on visual & somatosensory stimuli
 - enhance COR, corrective eye saccades, slower head movements
 - retrain postural control
- Sensory organization of visual, vestibular, and somatosensory input
- Motor organization
- Conditioning exercises

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Interventions: Distorted Vestibular Function

- Repositioning maneuvers
 - Brandt-Daroff habituation exercises
 - Liberatory maneuver (Semont)
 - Canalith Repositioning Maneuver (Modified Epley)
 - Habituation exercises
- Balance retraining
- Conditioning exercises

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Canalith Repositioning Maneuvers

- Treatment of BPPV based on the canalithiasis hypothesis
- Objectives:
 - move the canaliths from the canal to the utricle
 - accomplished via head maneuvers that rotate the target canal in the gravitational plane so that the canaliths migrate in the opposite direction

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Treatment Enhancement

- Nystagmus-based timing of the positioning sequence
- Vibration of the skull
- Repetition of the maneuvers at the same session & at F/U
- Alteration of the procedure on changed nystagmus observations
- Maintenance of a generally upright head position for 48 hours (*optional*)

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Interventions: Central Vestibular Dysfunction

- Dysfunction same as peripheral dysfunction with exception of \uparrow VOR gain
- Substitution exercises
- Habituation exercises with caution

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Interventions: Bilateral Vestibular Lesion

- Central preprogramming
- Modify saccadic & pursuit eye movements
- Potentiation of COR (*complements VOR*)
- Substitution with somatosensory stimuli
- Compensatory strategies eg., turn on lights...

Herdman, 2000

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Vestibular Exercises Efficacy

- Help in UVL if spontaneous recovery does not occur (*Norre & Deweerdt '80*)
- Diminish dizziness & dysequilibrium symptoms (*Horak et al '92*)
- VSR recovery noted with early intervention
- Improvement in vestibular function testing (*Herdman '95*)
- Increased overall functional activity level (*Gill-Body '94*)

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Cawthorne-Cooksey Exercises

- Address complaints of vertigo & impaired balance
- Include movements of head, head/eye coordination, total body movements, & balance tasks
- Exercises performed in various positions & at various speeds
- Encourage movement into positions that provoke symptoms

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Vestibular System Adaptation

- Long term changes that occur in response of vestibular system to input
- Adapts to dysfunction via central repair capability & redundant sensory & motor function
- Adaptation occurs as errors in performance are detected and corrected e.g., retinal slip
- Adaptive mechanisms:
 - vestibular spinal reflexes, VOR ...

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Adaptation Exercises

- Promote use of vestibular system , e.g.. VOR, VSR

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Adaptive Mechanisms

- Vestibular-ocular reflex (VOR)
- Vestibulospinal reflex (VSR)
- Vestibulocollic reflex (VCR)
- Cervico-ocular reflex (COR)

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Gaze Stabilization (GS)

- Maintenance of an image on the fovea during head movements (VOR)
- Older adults demonstrate a decreased ability to fixate a target during balance tasks
- Maximize head stability by disassociating head and trunk segments vs. unstable head in space due to rigid linking of head and trunk and resultant abnormal postural responses
- Adaptation of the VOR and resultant decrease in fall risk is believed to occur via vestibular specific GS exercises using adaptation and substitution exercises

Substitution Exercises

- Alternative strategies & sensory inputs
 - examples:
 - COR
 - VSR
 - Visual
 - Avoidance

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Cervicogenic Dizziness

- Disturbances to afferent input from the neck can cause dizziness, unsteadiness, visual changes, altered head and eye movement control
- Intervention
 - Oculomotor exercise
 - Eye-neck coordination
 - Progressive gait dual task activities
 - Standing balance
 - Environmental manipulation during gait
 - Daily HEP

Krisjansson, 2009

Habituation Exercises

- Desensitization to movements
- Use of repetitive movements
- Quantify status & progress by comparing responses to Motion Sensitivity Quotient

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Exercise Guidelines

- Emphasize fast & powerful muscle activity necessary for reactive balance control mechanism
- Include interlimb coordination as well as coordination between LE & upper body movements
- Multisegmental coordination will ensure better safety if postural responses do not completely recover

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Effort Exertional Headache

- Precipitated by any form of exercise e.g., impact activity, head movement
- Use post-concussion symptom scale to discuss S&S
 - Physical symptoms
 - Neuropsychiatric
 - Sleep disturbances
 - Cognitive symptoms
- Early intervention should include
 - Light aerobic, balance and vestibular exercise
 - No impact activity, limited head movement and concentration activities

Gait with Dual Task Performance

- Evidence of strong association between cognitive function and gait ability while performing another task e.g., math, obstacle course
- Compounding effect of cognitive and motor deficits on gait parameters
 - Slower gait speed
 - Shorter strides
 - Increased double support time
 - Increased stride variability
- Changes associated with increased fall risk in populations prone to fall

Yogev-Seligmann et al, 2008

Patient Education

- Recovery may be slowed by meds, colds, other CNS or peripheral disorders, age changes in visual, vestibular & somatosensory systems
- BVLs slower to recover (2 years)
- Postural stability may never be normal; adequate postural stability needs greater sensory cues
- Increased risk of falling; use of a cane or walker at first, home modification
- May need to continue exercises to maintain recovered function; walking is a fundamental daily activity
- Intrinsic (*fatigue*) and extrinsic factors (*uneven surfaces, low lighting*) contribute to vestibular function

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Vestibular Function Recovery Rates

- UVL: 6-8 weeks
- BPPV: remission in 1/few treatments
- BVL: 6 months - 2 years
- CNS Lesion: 6 months - 2 years

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Red Flags

- Sudden loss of hearing
- Increased pressure / fullness in ear
- Discharge of fluid from ears or nose
- Severe ringing in ear
- BP problems
- Increased CNS symptoms
- Increased visual problems

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Physical Therapy Intervention: Prescription

- Individualized vestibular rehabilitation program:
 - Outpatient, 1-2 times / week (4-6 weeks)
 - HEP, 5 minutes, 3x / day
 - Walking program (*health & fitness prescriptions*)
- Compliance to daily program essential to success
- Exercise graduated for possible increase of symptoms during the first week

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SUMMARY OF VESTIBULAR SYSTEM DISORDERS

| | BPPV | Vestibular Neuritis | Meniere's Disease | Fistula | Bilateral Vestibular Disorder |
|----------------------|-----------------------------|----------------------------|-----------------------------------------|-------------------------------------------------------------|--------------------------------------|
| Vertigo | + | + | + | + | - |
| Type | Rotational | Rotational | Rotational | Rotational/ linear | - |
| Nystagmus | + | + | + | + | - |
| Duration | ½-2 min. | 48-72 hr. | 30 min.-24 hr. | seconds | Permanent |
| Nausea | -/+ | + | + | - | - |
| Postural ataxia | -/+ | + | + | + | ++ |
| Specific symptoms | Onset latency, adaptation | Acute onset | Fullness of ear, hearing loss, tinnitus | Loud tinnitus, Tullio sign, Hennebert sign | - |
| Precipitating action | Positioning, turning in bed | - | - | Head trauma, ear surgery, sneezing, straining, nose blowing | - |

Herdman, S.J., 1994. Vestibular Rehabilitation. Philadelphia: F.A. Davis Co.

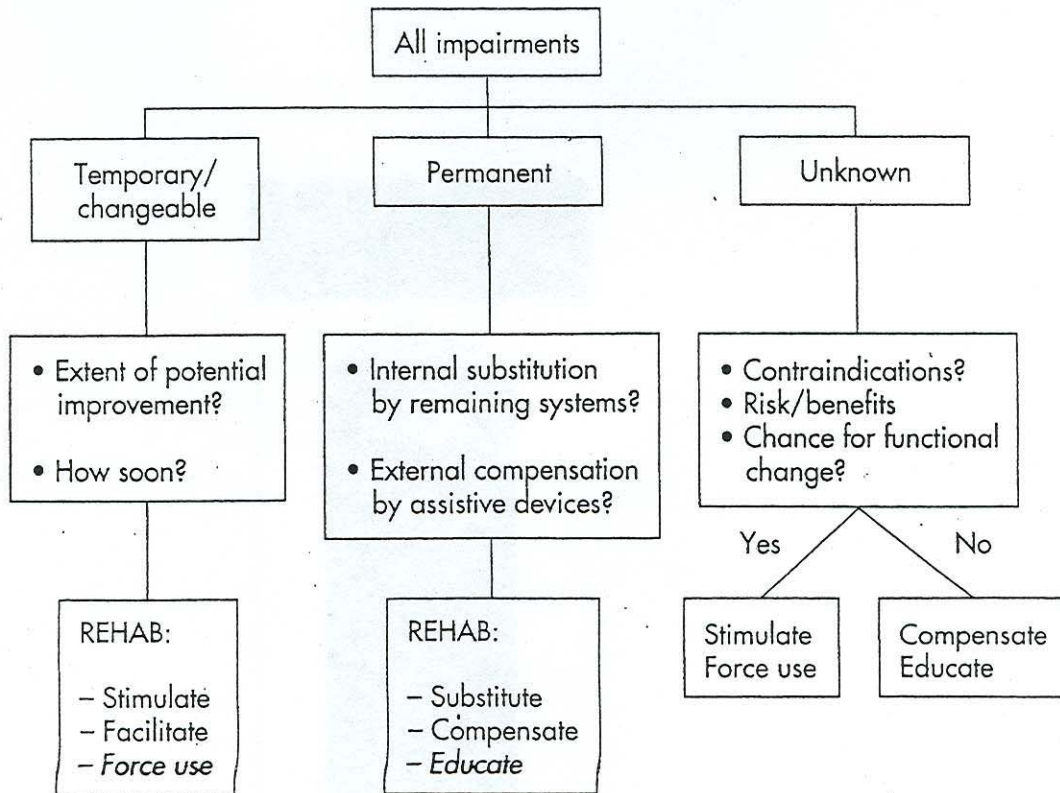
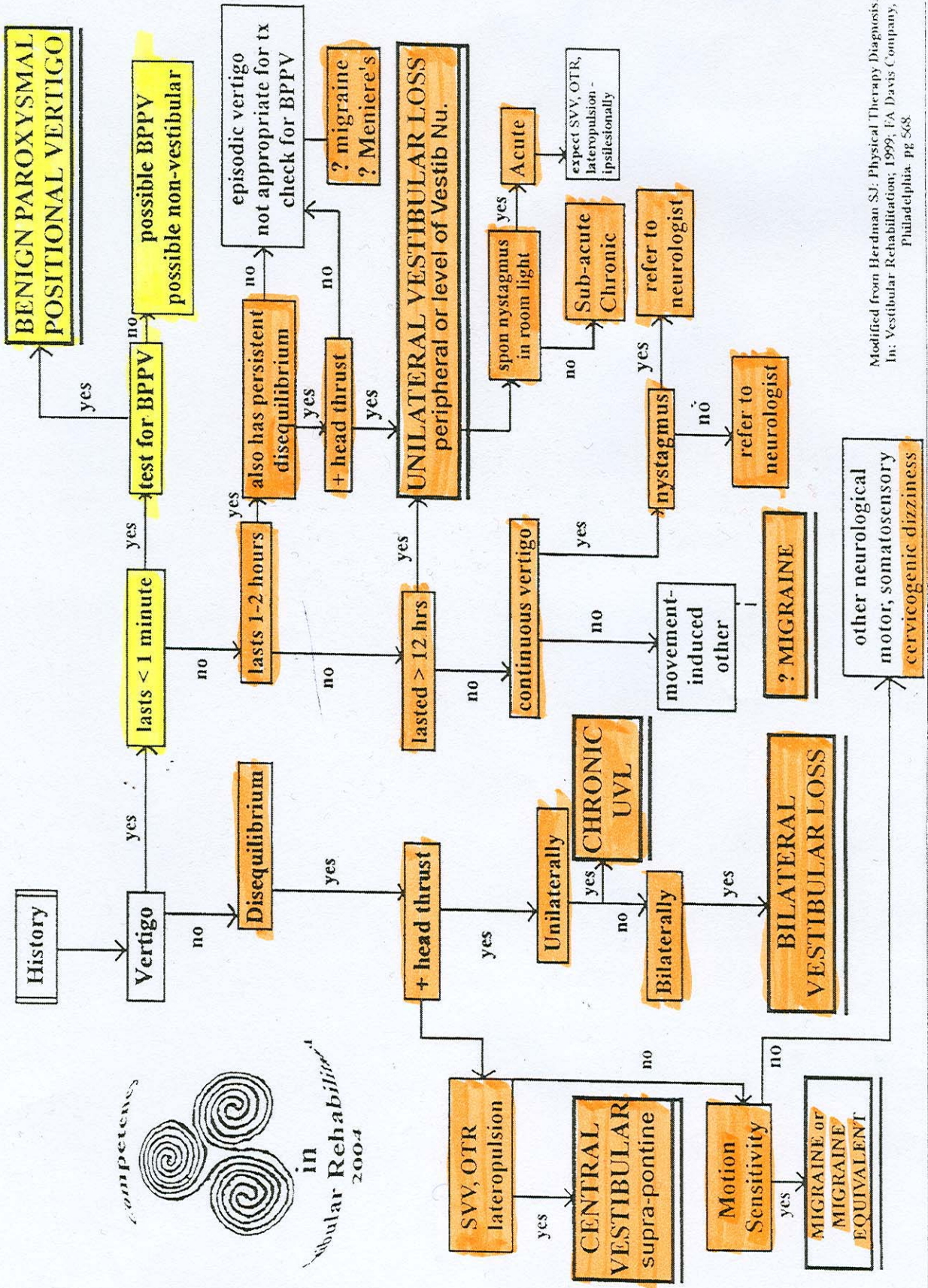


FIGURE 21-22. A clinical decision-making tree to illustrate the treatment-planning process in balance rehabilitation.

Umphred DA. *Neurological Rehabilitation*. 4th ed. St. Louis, MO: Mosby; 2001.

competence

 in
 Vestibular Rehabilitation
 2004



Modified from Herdman SJ: Physical Therapy Diagnosis. In: Vestibular Rehabilitation; 1999; FA Davis Company, Philadelphia. pg 568.

cm II
 cm III

Cawthorne-Cooksey Exercises for Patients with Vestibular Hypofunction

- A. In bed
1. Eye movements – at first slow, then quick
 - a. up and down
 - b. from side to side
 - c. focusing on finger moving from 3 ft. away from face
 2. Head movements at first slow, then quick; later with eyes closed
 - a. bending forward and backward
 - b. turning from side to side
- B. Sitting (in class)
1. and 2 as above
 3. Shoulder shrugging and circling
 4. Bending forward and picking up objects from the ground
- C. Standing (in class)
1. as A1 and A2 and B3
 2. Changing from sitting to standing position with eyes open and shut.
 3. Throwing a small ball from hand to hand (above eye level)
 4. Throwing ball from hand to hand under knee.
 5. Changing from sitting to standing and turning round in between.
- D. Moving about (in class)
1. Circle round centre person who will throw a large ball and to whom it will be returned.
 2. Walk across room with eyes open and then closed.
 3. Walk up and down slope with eyes open and then closed.
 4. Walk up and down steps with eyes open and then closed.
 5. Any game involving stooping and stretching and aiming such as skittles, bowls, or basketball.

Diligence and perseverance are required but the earlier and more regularly the exercise regimen is carried out, the faster and more complete will be the return to normal activity.

ACTIVITIES TO FACILITATE MOTOR COORDINATION

Methods of Promoting Ankle Strategy

Use small anteroposterior (AP) and mediolateral weight shifts, with hips extended on a variety of surfaces including a tilt board.

Alternate step-ups onto a small step without using a rail.

Use a Biomechanical Ankle Platform System (BAPS) board.

Alternate upper extremity flexion and extension.

Methods of Promoting Hip Strategy

Use large AP weight shifts on a variety of support surfaces.

Stand on a narrow support surface (i.e., balance beam).

Perform tandem standing and tandem walking.

Perform single-leg stance.

Strength and Coordination Exercises

Heel raises, toe raises.

Stationary biking, walking, jogging, rowing.

Isokinetics in functional patterns, including use of Kinetron®.

Rubber tubing exercises in standing.

Perturbations in standing, using functional electrical stimulation to augment synergic responses.

Movement classes (e.g., Tai Chi, modified aerobics, social dancing).

Activities to facilitate sensory organization for patients who demonstrate vestibular ocular reflex dysfunction or sensory selection problems.

Adapted from information presented by Ann Shumway-Cook, PhD, PT, at the Vestibular Rehabilitation course, Medical College of Ohio, Toledo, Ohio, February 1989.

VESTIBULAR SYSTEM TREATMENT SUGGESTIONS*

General body responses leading to relaxation

1. Slow rocking
2. Slow anterior-posterior: horizontal or vertical movement (chair, hassock, mesh net, swing, ball bolster, carriage)
3. Rocking bed or chair
4. Slow linear movements, such as in a carriage, stroller, wheelchair, or wagon
5. Therapeutic and/or gymnastic ball

Techniques to heighten postural extensors

1. Rapid anterior-posterior or angular acceleration
 - a. Scooter board: pulled or projected down inclines
 - b. Prone over ball: rapid acceleration forward
 - c. Platform or mesh net: prone
 - d. Slides
2. Rapid anterior-posterior motion in prone, weight-bearing patterns such as on elbows or extended elbows while rocking and crawling
3. Weight-shifting in kneeling, ½ kneel or standing

Facilitory techniques influencing whole body responses

1. Movement patterns in specific sequences
 - a. Rolling patterns
 - b. On elbows, extended elbows, and crawling: side by side, linear and angular motion
2. Spinning
 - a. Mesh net
 - b. Sit and spin toy
 - c. Office chair on universal joint
3. Any motor program that uses acceleration and deceleration of head
 - a. Sitting and reaching
 - b. Walking
 - c. Running
 - d. Moving from sit to stand

Combined facilitory technique: inverted tonic labyrinthine and inhibitory

1. Semi-inverted in-sitting
2. Squatting to stand
3. Total inverted vertical position

*Remember all of these treatment suggestions involve other input mechanisms and all aspects of the motor system and its components.

EXERCISES TO IMPROVE GAZE STABILITY

Enhance the Cervico-ocular Reflex

Tape a business card on the wall in front of you so that you can read it.
Move your head back and forth sideways, keep the words in focus.
Move your head faster but keep the words in focus. Continue to do this for 1-2 min. without stopping.
Repeat the exercise moving your head up and down.
Repeat the exercises using a large pattern such as a checkerboard (full-field stimulus).

Active Eye-Head Movements Between Two Targets

Horizontal Targets:

Look directly at one target being sure that your head is also lined up with the target.
Look at the other target with your eyes and then turn your head to the target (saccades should precede head movement).
Be sure to keep the target in focus during the head movement.
Repeat in the opposite direction.
Vary the speed of the head movement but always keep the targets in focus.
Note: Place the two targets close enough together that when you are looking directly at one, you can see the other with your peripheral vision. Practice for 5 min., resting if necessary. This exercise can also be performed with two vertically placed targets.

Imaginary Targets

Look at one target directly in front of you.
Close your eyes and turn your head slightly, imagining that you are still looking directly at the target.
Open your eyes and check to see if you have been able to keep your eyes on the target.
Repeat in the opposite direction. Be as accurate as possible.
Vary the speed on the head movement.
Practice for up to 5 min., resting if necessary.

Home Exercise Program
EXERCISES TO IMPROVE POSTURAL STABILITY

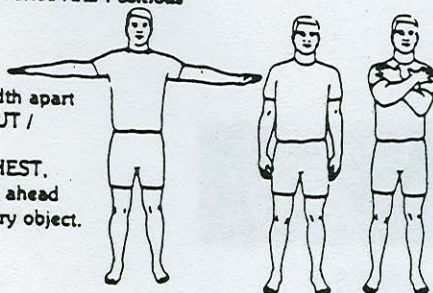
1. Practice walking
turning head from one side to the other
10 minutes, 3 times a day
2. Practice marching in place
eyes open, eyes closed
50 steps
3. Step Ups on a small step
move arms up and down as you step up and down
progress to performing above drill with eyes closed
4. Practice heel raises, toes raises
15 times each day
5. Practice rocking in a rocking chair
eyes open, eyes closed
6. Ball activities
basketball drills
soccer drills
7. Practice single leg standing
eyes open, eyes closed
progress to 30 second holds
8. Standing one leg in front of the other
eyes open, eyes closed
progress to 45 second holds
9. Perform above standing drills on a foam surface
use 2-3 inch foam surface, or a minitrampoline

Perform drills three times a day, spending at least 5 minutes on each session.

BALANCE DRILLS

STANDING STATIC Foot Apart: Varied Arm Positions

With feet shoulder width apart and arms OUT / AT SIDES / ACROSS CHEST, look straight ahead at a stationary object.

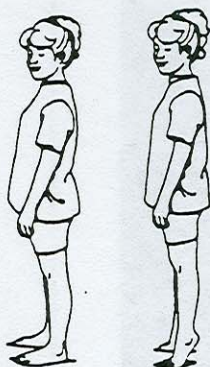


STANDING STATIC Eyes Closed: Feet Heel-Toe "Tandem"

Stand with RIGHT / LEFT foot directly in front of the other. Close eyes and visualize upright position. Perform with arms OUT / AT SIDES / ACROSS CHEST.



ANKLE/FOOT Standing Bilateral Heel Rise



ANKLE/FOOT

Standing Toe Raise

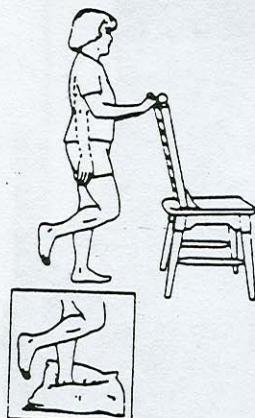
Rock back on heels.



STANDING STATIC Single Leg (Varied Surfaces)

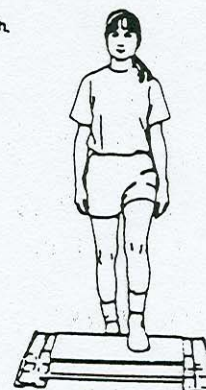
Holding on to support, lift RIGHT / LEFT leg up while maintaining balance over single leg.

Progress to removing hands from support surface for longer periods of time



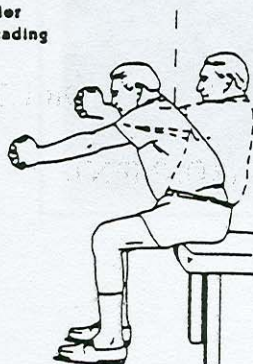
CLOSED CHAIN Proprioception, Quad Strength, Timing, Coordination: Forward Step-up

Move onto step, one foot then the other. Step back off the same way.



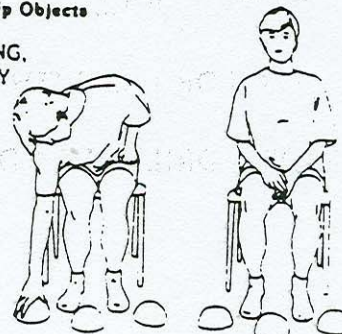
SITTING Unsupported Anterior / Posterior Weight Shift: Lower Trunk Leading

Sit with feet flat on floor, hands clasped together in front. Lean forward through hips bringing nose over knees. Return. Then lean backward through hips.



HABITUATION Bending / Picking Up Objects

SITTING / STANDING, SLOWLY / QUICKLY bend head down and pick up object placed on floor. Return to upright position.



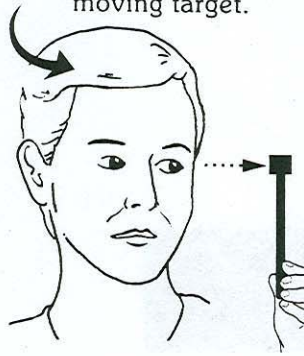
EYE EXERCISES - 2

Movements: Head / Eyes (Pictorial Reference)

Eyes fixed on target, head moves opposite direction of moving target.



Eyes fixed on target, head moves same direction as moving target.

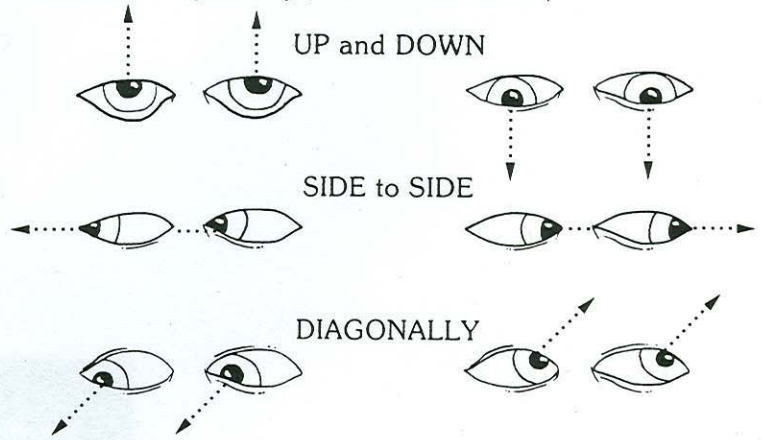


*Therapist: Use this card with Eye Exercise 3 and 4.

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EYE EXERCISES - 1

Movements: Eyes Only (Pictorial Reference)



*Therapist: Use this card with Eye Exercises 3 through 6.

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EYE EXERCISES - 4

Visuo-Vestibular: Head / Eyes Moving in Opposite Direction

Holding a single target, keep eyes fixed on target. Slowly move target UP-DOWN / SIDE TO SIDE / DIAGONALLY

while moving head in opposite direction of target for ___ seconds each direction.

Perform in _____ position.

Repeat ___ times per session. Do ___ sessions per day.

Repeat using full field stimulus _____.



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EYE EXERCISES - 3

Visuo-Vestibular: Head / Eyes Moving in Same Direction

Holding a single target, keep eyes fixed on target. Slowly move target, head and eyes in same direction UP-DOWN / SIDE TO SIDE / DIAGONALLY

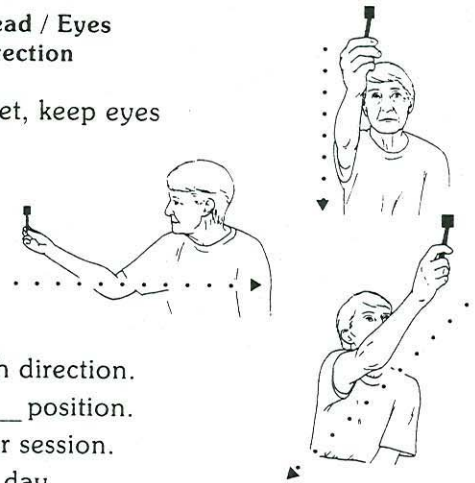
for ___ seconds each direction.

Perform in _____ position.

Repeat ___ times per session.

Do ___ sessions per day.

Repeat using full field stimulus _____.



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EYE EXERCISES - 6

Oculomotor: Saccades

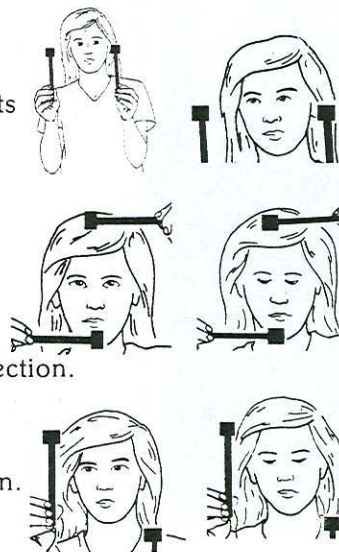
Holding two stationary targets placed ___ inches apart SIDE TO SIDE / UP-DOWN / DIAGONALLY, move eyes quickly from target to target as head stays still.

Move ___ seconds each direction.

Perform in _____ position.

Repeat ___ times per session.

Do ___ sessions per day.



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EYE EXERCISES - 5

Oculomotor: Smooth Pursuits

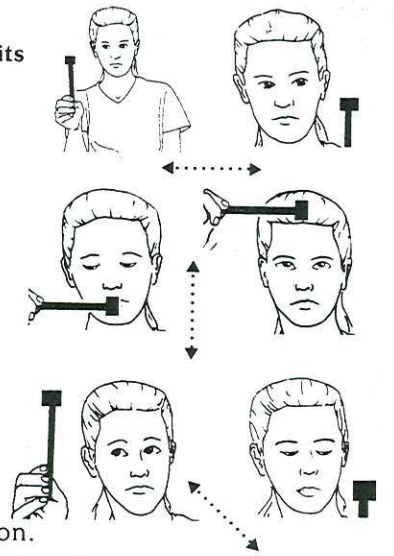
Holding a single target, keep eyes fixed on target. Slowly move it SIDE TO SIDE / UP-DOWN / DIAGONALLY while head stays still.

Perform in _____ position.

Move ___ seconds each direction.

Repeat ___ times per session.

Do ___ sessions per day.

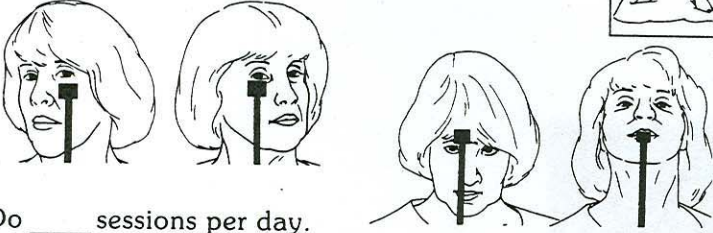


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EYE EXERCISES - 14

Gaze Stabilization: Standing Feet Apart (Compliant Surface)

On pillow with feet apart,
keep eyes still on single stationary target
held in hand or placed on wall _____ feet away
and move head side to side for _____ seconds.
Repeat while moving head
up and down for _____ seconds.



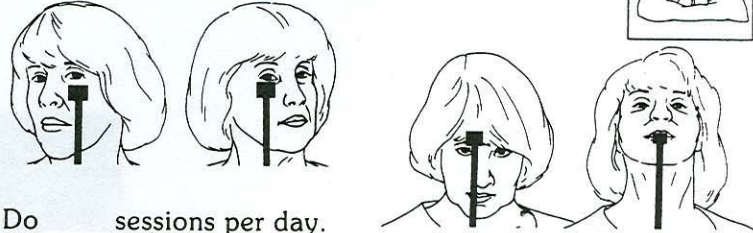
Do _____ sessions per day.

Repeat using full field stimulus _____ . Copyright VHI 1997 (BVS)

EYE EXERCISES - 15

Gaze Stabilization: Standing Feet Together (Compliant Surface)

On pillow with feet together,
keep eyes still on single stationary target
held in hand or placed on wall _____ feet away
and move head side to side for _____ seconds.
Repeat while moving head
up and down for _____ seconds.



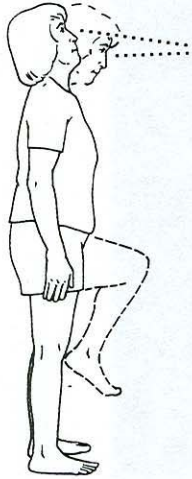
Do _____ sessions per day.

Repeat using full field stimulus _____ . Copyright VHI 1997 (BVS)

EYE EXERCISES - 17

Gaze Stabilization: Marching in Place

While marching in place on SOLID /
COMPLIANT SURFACE _____,
keep eyes fixed on a single
stationary target
placed on wall _____ feet away
and move head
up and down
_____ seconds.
Repeat while
moving head
side to side
for _____ seconds.



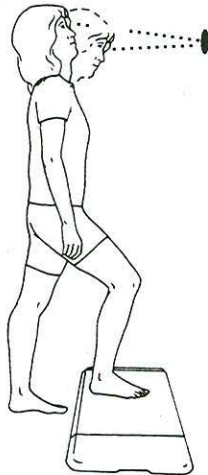
Do _____ sessions per day.

Repeat using full field stimulus _____ . Copyright VHI 1997 (BVS)

EYE EXERCISES - 16

Gaze Stabilization: Standing With Foot on Step

With RIGHT / LEFT foot
on a _____ inch step,
keep eyes fixed on a
single stationary target
placed on wall _____ feet away
and move head
up and down for _____ seconds.
Repeat while
moving head
side to side
for _____ seconds.



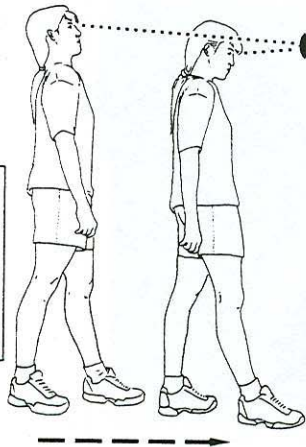
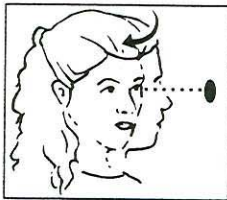
Do _____ sessions per day.

Repeat using full field stimulus _____ . Copyright VHI 1997 (BVS)

EYE EXERCISES - 18

Gaze Stabilization: Walking Toward Target

Keeping eyes fixed
on a single stationary target,
walk toward target
placed on wall _____ feet
away at eye level.
Moving head
up and down
for _____ seconds.
Repeat while
moving head
side to side
for _____ seconds.



Do _____ sessions per day.

Repeat using full field stimulus _____ . Copyright VHI 1997 (BVS)

EYE EXERCISES - 8

Gaze Stabilization: Tip Card

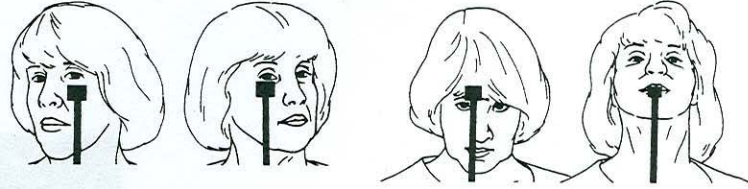
1. Target must remain in focus, not blurry, and appear stationary while head is in motion.
2. Perform exercise with small head movement (45° to either side of midline).
Speed of head motion should be increased as long as target remains in focus.
4. If you use glasses, wear them while performing exercises.
5. These exercises may provoke symptoms of dizziness or nausea. Work through these symptoms. If too dizzy, slow head movement down slightly. Rest between each exercise.
6. Exercises demand concentration, avoid distractions.
7. For safety, standing exercises must be performed close to a counter or next to someone.

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EYE EXERCISES - 9

Gaze Stabilization: Sitting

Keep eyes fixed on single stationary target held in hand or placed on wall ___ feet away and move head side to side for ___ seconds. Repeat while moving head up and down for ___ seconds.



Do ___ sessions per day.

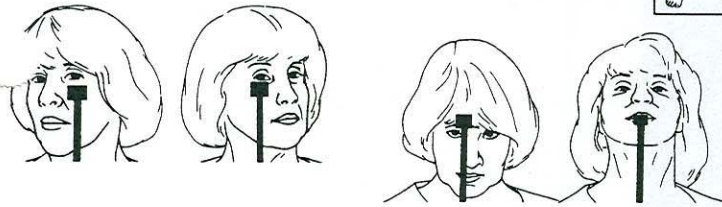
Repeat using full field stimulus _____.

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EYE EXERCISES - 10

Gaze Stabilization: Standing Feet Apart

Keep eyes fixed on single stationary target held in hand or placed on wall ___ feet away and move head side to side for ___ seconds. Repeat while moving head up and down for ___ seconds.



Do ___ sessions per day.

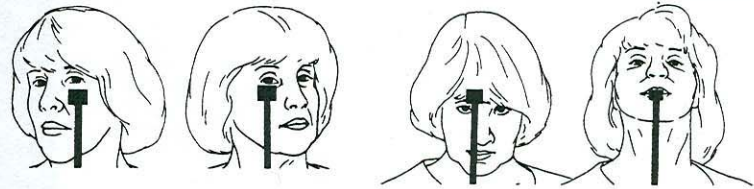
Repeat using full field stimulus _____.

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EYE EXERCISES - 11

Gaze Stabilization: Standing Feet Together

Keep eyes fixed on single stationary target held in hand or placed on wall ___ feet away and move head side to side for ___ seconds. Repeat while moving head up and down for ___ seconds.



Do ___ sessions per day.

Repeat using full field stimulus _____.

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EYE EXERCISES - 12

Gaze Stabilization: Standing Feet Partial Heel-Toe

With feet in partial heel-toe position keep eyes fixed on single stationary target held in hand or placed on wall ___ feet away and move head side to side for ___ seconds. Repeat while moving head up and down for ___ seconds.



___ sessions per day.

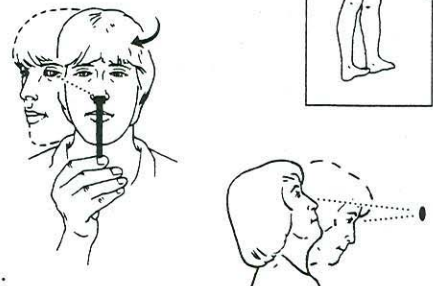
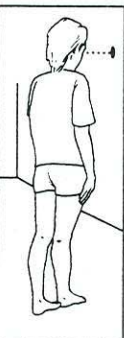
Repeat using full field stimulus _____.

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EYE EXERCISES - 13

Gaze Stabilization: Standing Feet Heel-Toe Tandem

With feet in full heel-toe position keep eyes fixed on single stationary target held in hand or placed on wall ___ feet away and move head side to side for ___ seconds. Repeat while moving head up and down for ___ seconds.



Do ___ sessions per day.

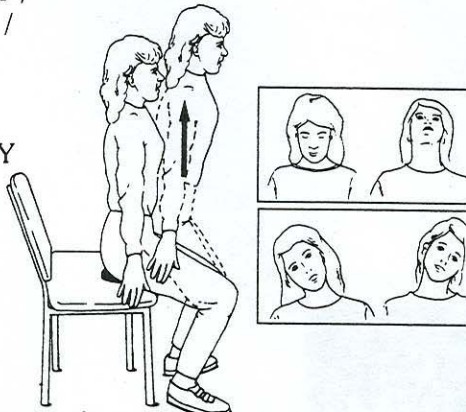
Repeat using full field stimulus _____.

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OTOLITH STIMULATION - 1

Sit to Stand: Varied Speeds (With Head Tilts)

With head UPRIGHT /
or tilted FORWARD /
BACKWARD /
RIGHT / LEFT,
stand up
SLOWLY / QUICKLY
with eyes
OPEN / CLOSED.



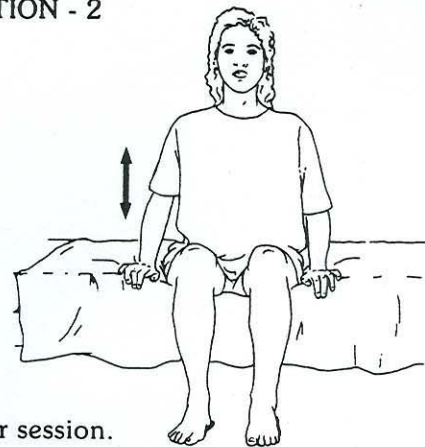
Repeat ___ times per session.
Do ___ sessions per day.

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OTOLITH STIMULATION - 2

Bouncing: On Bed

While sitting
at edge of bed,
bounce up and down
with eyes
OPEN / CLOSED.



Repeat ___ times per session.
Do ___ sessions per day.
 Repeat with eyes fixed
on stationary target.

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OTOLITH STIMULATION - 3

Jumping: In Place

Jump in place
with eyes
OPEN / CLOSED.



Repeat ___ times per session.
Do ___ sessions per day.

Repeat with eyes fixed on stationary target.

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OTOLITH STIMULATION - 4

Head Tilt: Forward

Maintain head
tilted forward,
while performing
exercise(s)* _____

_____.



**Therapist: On a copy of this card, fill in titles and numbers of exercises patient is to perform with this head position. Then photocopy that copy along side corresponding exercise cards.*

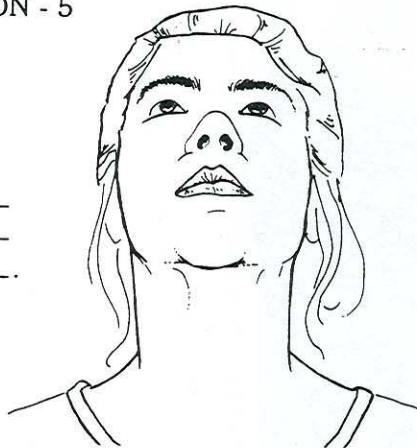
Copyright VHI 1997 (BVS)

OTOLITH STIMULATION - 5

Head Tilt: Backward

Maintain head
tilted backward,
while performing
exercise(s)* _____

_____.



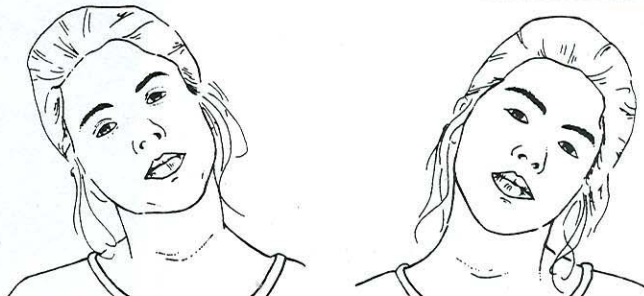
**Therapist: On a copy of this card, fill in titles and numbers of exercises patient is to perform with this head position. Then photocopy that copy along side corresponding exercise cards.*

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OTOLITH STIMULATION - 6

Head Tilt: Lateral

Maintain head tilted to RIGHT / LEFT
while performing exercise(s)* _____
_____.



**Therapist: On a copy of this card, fill in titles and numbers of exercises patient is to perform with this head position. Then photocopy that copy along side corresponding exercise cards.*

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HABITUATION - 1

Tip Card

1. Goal of habituation training is to assist in decreasing symptoms of vertigo, dizziness, or nausea provoked by specific head and body motions.

These exercises may initially increase symptoms; however, be persistent and work through symptoms. With repetition and time the exercises will assist in reducing or eliminating symptoms.

3. Exercises should be **stopped / discussed** with instructor if you experience any of the following:

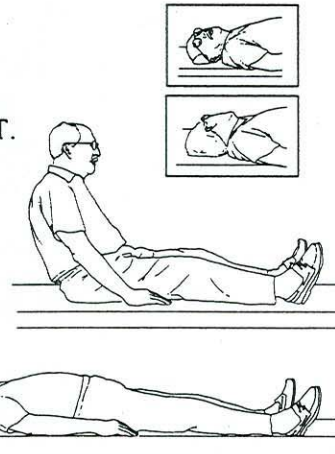
- Sudden change or fluctuation in hearing.
- New onset of ringing in ear, or increase in current intensity.
- Any fluid discharge from ear.
- Any pain in ear.
- Severe pain in neck or back.

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HABITUATION - 2 ; Long Sitting to Lying on Back

sit with legs extended, head UPRIGHT and CENTERED / ROTATED 45° TO RIGHT / LEFT. SLOWLY / QUICKLY

lie on back without pillow and maintain position until symptoms subside, plus ___ seconds. sit up SLOWLY / QUICKLY and maintain this position until symptoms subside, plus ___ seconds.



Repeat entire sequence ___ times per session.

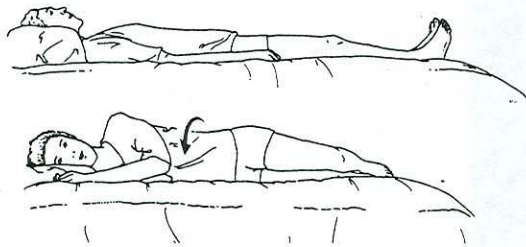
Do ___ sessions per day.

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HABITUATION - 3

Rolling

With pillow behind head, start on BACK / RIGHT / LEFT side. Roll SLOWLY / QUICKLY onto RIGHT / LEFT side. Maintain position until symptoms subside, plus ___ seconds. Return SLOWLY / QUICKLY onto back.



Repeat entire sequence ___ times per session.

Do ___ sessions per day.

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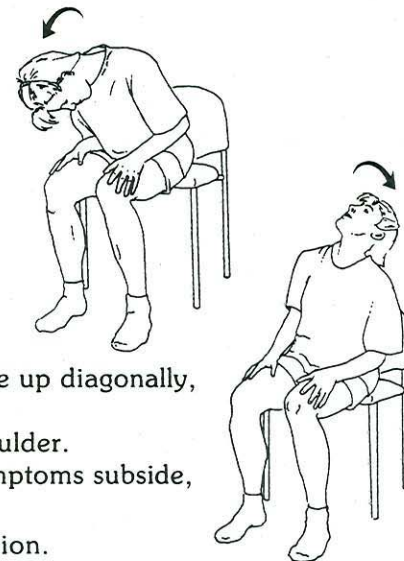
HABITUATION - 4

Diagonals

SITTING / STANDING SLOWLY / QUICKLY bring head down with nose in direction of RIGHT / LEFT knee. Maintain position until symptoms subside, plus ___ seconds. SLOWLY / QUICKLY come up diagonally, extending back of head toward RIGHT / LEFT shoulder. Maintain position until symptoms subside, plus ___ seconds.

Repeat ___ times per session.

Do ___ sessions per day.



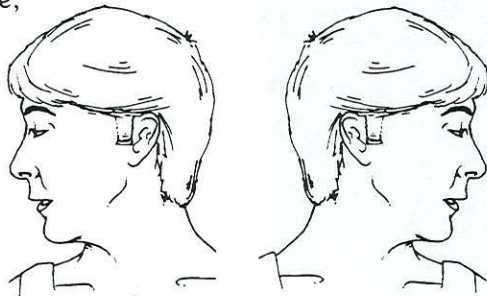
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HABITUATION - 5

Head Motion: Side to Side

While in ___ position, tilt head down 30°, SLOWLY / QUICKLY move head RIGHT / LEFT with eyes OPEN / CLOSED.

Let symptoms subside, plus ___ seconds, with each repetition.



Repeat ___ times per session.

Do ___ sessions per day.

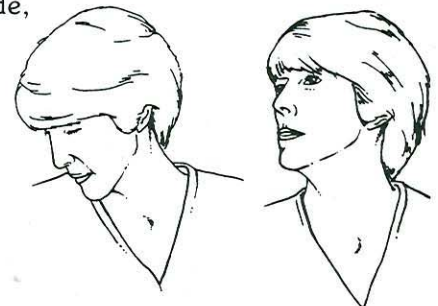
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HABITUATION - 6

Head Motion: Up / Down

While in ___ position, turn head 45° to RIGHT / LEFT. SLOWLY / QUICKLY move head UP / DOWN with eyes OPEN / CLOSED.

Let symptoms subside, plus ___ seconds, between each repetition.



Repeat ___ times per session. Do ___ sessions per day.

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