

Postural Instability and Vestibular Deficits Associated with Concussion: Assessment and Treatment

Rachel Gleason PT, MS, DPT
University of Kentucky

Concussion

- Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.
- Assessment covers range of domains including clinical symptoms, physical signs, behavior, balance, sleep and cognition.

McCorry 2009

Post Concussion Syndrome

- Persistent physical, cognitive, emotional, and/or behavioral symptoms following mTBI
- Resolution month – years
- Prevalence at 3 month post-injury: 24-84%
- Believed to be related to pre-morbid, injury and post-morbid factors

(Ryan 2003)

Symptoms

- Headache (HA)
 - Fatigue
 - Difficulty thinking/concentrating
 - Dizziness
 - Memory problems
 - Balance problems
 - Irritability
 - Visual Disturbances
 - Sensitivity to noise
 - Depression
 - Anxiety
- (Ryan 2003, Lovell 2006, Zemek 2013, Bergman 2013)

Symptoms

- symptoms dizziness and balance problems are associated with measurable deficits in postural control (Broglio 2009)
- loss of consciousness, HA, nausea/vomiting, dizziness may be prognostic indicators of PCS (Zemek 2013)

Symptoms

- HA may contribute to increased balance deficits as a result of increased sensory organization challenges (Mihalik 2008)

Concussion Evaluation

Assessment across a range of domains: symptoms, physical signs, behavior, balance, sleep, cognition (McCrorry 2009)

Physical Therapist:

- Objective assessment of balance
- Assessment of symptoms such as dizziness, visual disturbance

Management

- Cornerstone of concussion management: physical and cognitive rest
 - Modified by factors that require additional management
- Graded exertion program
- Return to play

(McCrorry 2009)

Recovery

- symptom-free at rest
- normal neurocognitive and balance testing
- no abnormalities with return to full cognitive and physical activity

(Lovell 2004, McCrorry 2009)

Multidisciplinary Team

- MD
- Neuropsychologist
- Physical Therapist
- Neuro-ophthamologist

Physical Therapist

Assessment of the Vestibular, Oculomotor and Balance Systems

Individualized and targeted intervention



For clients who suffer from dizziness and/or imbalance following concussion....

vestibular rehabilitation is effective

(Alsalaheen 2010)

Physical Therapy Evaluation

- History
- Systems Screen
- Oculomotor exam
- Vestibular Testing
- Positional Testing
- Balance Assessment

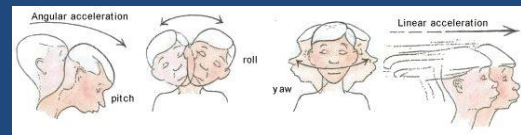
History

- Date of Injury
- Current Symptoms:
 - Dizziness, HA (migraine?), visual disturbance, disequilibrium, pain, auditory disturbance, fatigue, decreased concentration, memory loss etc.
- Prior Concussion

Why dizziness? Why Imbalance?

Vestibular System

- 1) Senses head position and acceleration - linear and angular



Vestibular System

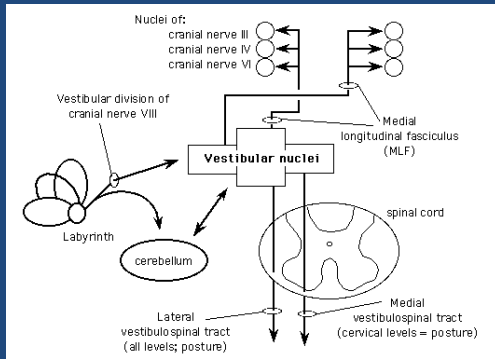
- 2) Stabilization of gaze

- 3) Postural control
 - Via Vestibular reflexes: vestibulo-spinal and vestibulo-ocular



Vestibular Apparatus

- Labyrinth of inner ear, petrous portion of temporal bone
- Vestibulocochlear (VIII cranial) nerve
 - Superior
 - Inferior
- Vestibular nuclei, cerebellum, brainstem
- Parieto-temporal cortex



Etiology

Vestibular Pathology

Peripheral

- Benign Paroxysmal Positional Vertigo
- Labyrinthine Concussion
- Perilymphatic Fistula

Central

- Brainstem, Cerebellar
- Migraine

Cervicogenic

Common causes....

Oculo-motor abnormalities

Gaze stability

Migraine

Orthostatic hypotension

PT Examination



Oculomotor Exam

Central and peripheral pathology

Assessing eye movement, nystagmus, symptoms

Common Dysfunction:

convergence, misalignment, saccade/pursuit impairment, VOR dysfunction, gaze holding nystagmus

PT Examination Oculomotor Exam

Spontaneous nystagmus (without fixation)

- ⊙ Instruct patient to gaze straight ahead;
- ⊙ ABN: nystagmus

Gaze-evoked nystagmus (without fixation) (peripheral or central)

- ⊙ Instruct patient to gaze at tip of finger position 30° left, right, up, down from center,
- ⊙ ABN: nystagmus (note direction changing; effects of fixation to distinguish)

Oculomotor Exam

Ocular ROM/ Smooth Pursuit

- ⊙ Instruct patient to follow tip of finger 30° (about 6 inches) left, right, up, down;
- ⊙ ABN: disconjugate eye movement, restrictions in ROM

Saccades (Hor/Vert)

- ⊙ Instruct pt to look back and forth between two fingers;
- ⊙ ABN: disconjugate mvmt, over- or under shooting

Oculomotor Exam

Cover/Uncover; cross cover test - misalignment

- Cover then uncover eye
- ABN: movement of redress onto target

Vergence

- Use patient's thumb, eyes follow in/out

Oculomotor Exam

VOR Testing(screen Cx ROM 1st)

- Patients head tilted forward 30°, patient instructed to maintain gaze of your nose, rotate patients head slowly (<2Hz) and rapidly (>2Hz);
- ABN: unable to maintain gaze/focus
- *Work into head thrust tests*

PT Examination

VOR testing

Head thrust (screen Cx ROM 1st)

- Pts head tilted forward 30°, patient instructed to maintain gaze of your nose, manually thrust/rotate (small amplitude: 5°- 15°, high acceleration) patients head in an unpredictable direction;
- ABN: corrective saccade



PT Examination

VOR testing

Dynamic visual acuity (DVA)

- instruct pt to read the lowest line possible with head stationary then flex patient's head forward 30° and manually bilaterally oscillate patient's head at 2 Hz, instruct pt read the lowest line possible;
- ABN: drop of three or more lines of acuity (i.e. 20/20 to 20/60)
- Reliable outcome measure in clients with TBI (Gottshall 2003)



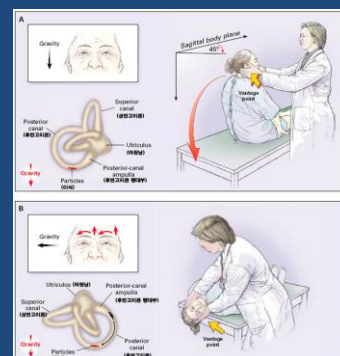
Positional Testing

- Incidence BPPV with concussion is low: <5% (Alsalaheen 2010)

As indicated:

- Dix-Hallpike
- Roll Test

Positional Testing



Balance Assessment

- Static and Dynamic
- Gait
- Sensory Organization
- Self Report Measures



Assessment of Balance

Static and Dynamic

- Romberg
- BESS – developed specifically for concussed athletes
- Star Excursion
- Five Time Sit to Stand
- BESTest and miniBEST

Assessment of Balance

Gait:

- Functional Gait Index
- Dynamic Gait Index
- High Level Mobility Assessment Tool

Sensory Organization:

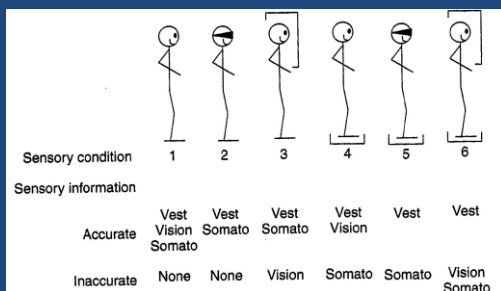
- Computerized Dynamic Posturography (CDP) – Sensory Organization Testing (SOT), Head Shake SOT

Balance Assessment

Sensory Organization Test (SOT)

- monitor body sway under 6 conditions that alter or eliminate visual and somatosensory input
- pattern of increased sway or falls indicative of sensory deficits/sensory dependence

Sensory Organization Test



Self-Report Measures

Dizziness Handicap Inventory (DHI)

- Reliable outcome measure TBI (Gottshall 2003)

Activity-Specific Balance Confidence Scale (ABC)

Intervention

Important Considerations:

- Monitor symptoms during each session
- Oculo-motor training as needed
- Recovery may be slow – advance slowly
- Limit exertion according to symptoms
- Multi-disciplinary team approach

Intervention

Rehab plan is individualized specific to exam findings

Post-concussion, clients with lingering dizziness, imbalance receiving vestibular rehab are most commonly prescribed:

- Eye-head coordination
- standing static balance exercises
- ambulation exercises

(Alahasheen 2012)

Oculomotor Training

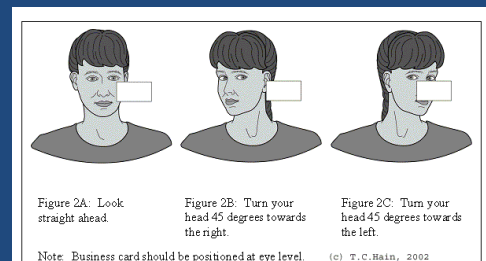
Gaze Stabilization Exercises:

- Dynamic vestibular dysfunction
- Visual blurring, disequilibrium/gt ataxia, limited trunk/head rotation due to decreased VOR gain
- plasticity – ability of vestibular system to make changes in neuronal response to input
- Goal- regain gaze stability and postural control

Oculomotor Training

Gaze Stabilization: VORX1 - VORX2

- 1 min – 2 min
- Seated – standing – foam – unilateral – walking
- Blank background – full field
- Add mental task
- Perform with eyes closed or in dark



Oculomotor Training



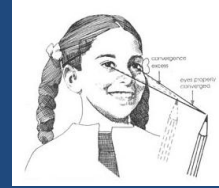
Brock String:

- Vergence insufficiency, binocular vision
- 10ft white string, 3 beads different colors

Oculomotor Training

Pencil Push-ups:

- Convergence insufficiency



Balance and Gait

Specific and targeted balance and gait program:

- Include sensory organization challenges
- Include task and environmental challenges
- Include mental challenges
- Dual task training

Monitor symptoms and limit exertion – especially early on

Case Study

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