Post Concussion Rehab: Vestibular Therapy

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Disclosure Statements

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This course provides an overview of frequently observed vestibular and ocular motor abnormalities following concussion. The functional implications of these findings and potential rehabilitation interventions for identified dysfunction will be discussed.

CE Objectives: At the end of the course, attendees should be able to:
• Identify vestibular and oculomotor abnormalities commonly observed after concussion
• Restate approaches to assess the functional implications of vestibular and oculomotor abnormalities
• Review evidence-based rehabilitation strategies to manage any identified vestibular and oculomotor dysfunction
Speaker Biography

Nathan Diffenbaugh, MSPT, DPT, ITPT
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Lehigh Valley Health Network
Allentown, PA

- Received Bachelors in Health Science and Masters of Science in Physical Therapy from College Misericordia
- Completed Doctorate of Physical Therapy at Misericordia University
- Completed APTA Vestibular Competency course and APTA's Credentialed Clinical Instructor program
- Became an ImPACT Trained Physical Therapist in 2017
- serves as part of a multi-disciplinary team that supports the LVHN Concussion and Head Trauma program
- Specializes in concussion treatment from accidents to professional athletes
- Has contributed to CE opportunities provided in areas of Vestibular and Post-concussion Rehabilitation
Learning Objectives

• Obtain a basic understanding of evidence supporting Vestibular Interventions

• Understand how to properly assess for functional deficits of the vestibular and oculomotor systems

• Review common interventions and strategies to promote functional recovery
Concussion by the Numbers
Basic Facts

Centers for Disease Control reports

• In 2012 roughly 329,290 children were treated in US Emergency Departments for sports or recreation related Concussion/TBI

• Rates of ED visits more than doubled from 2001 to 2012 for these injuries

• Causes for TBI visits over all ages

1. Falls
2. Struck by object
3. Motor vehicle accidents
Basic Facts

Pediatric Sports Related Concussion Estimates

• In study published in Pediatrics in 2016
  • Estimated that between 1.1 to 1.9 million sports related concussions occur annually in US children (ages 18 years or younger)
  • Of this 511,590 to 1,240,972 are estimated to not receive medical care
  • Majority of patients seen are cared for in an outpatient setting
Pediatric Concussion

• A study by Corwing et al found that 81% of the pediatric patients evaluated for the study had vestibular impairment
  • Roughly 0.8% of normative healthy pediatric population will test with a vestibular deficit
  • Utilized Vestibular Ocular testing and tandem ambulation
  • Individuals with Vestibular deficits took longer to return to sports and school compared to injuries without vestibular dysfunction
  • Those with vestibular impairment also scored lower on neurocognitive testing (ImPACT)
Validation for Vestibular Rehab

• Bara et al demonstrated that vestibular therapy appears to help in patients with dizziness and balance problems without variations among age

• Anzalone et al demonstrated that a positive relation between poor performance on VOMS in the pediatric population may indicate longer recovery time

• Leddy et al demonstrated that subjective reports cannot distinguish between physiologic symptoms and vestibular/cervicogenic symptoms in Post Concussion Disorder
Concussion Management.com

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Berlin: 5th International Conference

Consensus statement supports

• Use of vestibular therapy for individuals not recovering in a normal time frame
• Closely monitored active rehabilitation programs
• Use of sub-symptom-threshold and sub-maximal exercise
• Serves as the basis for many Concussion Care recommendations and pathways
An Overview of the Vestibular System
Vestibular system

- One Labyrinthine located in each ear
- Connected to brain through 8th Cranial Nerve
- Components
  - Semicircular Canals: Horizontal, Anterior, Posterior
  - Otolith Organs: Saccule and Utricle
Roles of Vestibular System

• Senses acceleration and position of the head in order to create an awareness of orientation and movement within space

Uses:
• Gaze stability
• Postural Stability
• Orientation in space
• Autonomic Nervous System modulation
Roles of the Vestibular System

Gaze Stability
• Vestibular Ocular Reflex: Moving eyes opposite direction of head motion at equal speed

Postural Stability
• Vestibular Spinal Reflex is utilized along with visual and somatosensory cues to maintain balance

Orientation in Space
• What is upright

Autonomic Nervous System modulation
• Cerebral perfusion and breathing
Examination: Oculomotor, Vestibular, and Balance Assessments
Examination

Full subjective report

Common complaints
• Vertigo, Lightheaded, Off Balance, Falls, Foggy, Blurred Vision, Diplopia, Oscillopsia, Motion Sensitivity, Discomfort or Problems in a Busy Environment, Neck Pain

Red Flags – proceed with caution
• The 5 D’s
• Diplopia, Dysarthria, Dysphagia, Drop Attacks, Dysmetria
Examination

• Clear cervical spine prior to vestibular and oculomotor examination
• Assess for ligamentous and Atlanto-axial injury
• Assess for vertebral perfusion impairment
  • Vertebral artery test

• Completion of Oculomotor examination
  • Vestibular Ocular -Motor Testing (VOMS)
    • Form can be found on ImPACT Applications’ Website – Excellent for those with limited vestibular experience *please note the following slides differ from VOMS
    • VOM’s identifies a there is a problem – PT/OT wants to identify the specific dysfunction

• Positional testing
Oculomotor Testing

Smooth Pursuits

• Voluntary controlled tracking movement
• Requires a target for fixation
• Use tip of pen/finger pointing at patient or patient holds target
Oculomotor Testing – Smooth Pursuits

Assess in horizontal and vertical planes.
- Can use H, X, or circular pattern to better assess control

Look for:
- Jerky (saccadic) motion
- Inability to stay on target
- Stop at a point away from midline to observe for gaze holding nystagmus
- Nystagmus: repetitive uncontrolled movement on the eye which contains a slow and a fast phase
- Nystagmus is named by the fast phase direction
Oculomotor Testing

Saccades
• Ballistic movement of eye, unconscious movement

Utilize 2 targets
• Patient can hold targets
• Utilize pen and nose
• Utilize two fingers
• Re-fixate from one target to the other target
• Ask patient to go as fast as they can
Oculomotor Testing

Saccades

• Look for corrective motions
• One corrective saccade may be normal
• Undershooting/overshooting (hypometric/hypermetric)
• Hypermetric is typically indicative of cerebellar disorder/pathology
Convergence

Assessing for equal ocular adduction (Cross Eyes)
• Have patient follow target in towards nose

Measure at the point which pt reports diplopia from nose
• Pt may suppress one eye and will report not seeing double
• Be aware of prior corrective lenses needs
• Ask if they have a history of strabismus
• If something appears abnormal document it
  • Look at a “selfie”

• Watch for the eye appearing to stop or unequal motion
Vestibular Ocular Reflex (VOR)

• Used to stabilize gaze in space during head movement
• Eyes move opposite direction of the head to maintain focus
• Normal VOR: As head moves eyes remain focused on target
• VOR slip: As head moves eyes do not stay on target. A corrective saccade occurs in order for eyes to return to target
VOR

• Cervical ocular reflex can work up to 1 Hz

• Assess at 1 Hz and 2 Hz with head at 30 degrees of flexion – to target horizontal canal

• Rotate patients head while they focus on your nose or have the patient hold a target and turn head.
Head Thrust Test/Head Impulse Test

• Head positioned at 30 degrees of flex
• Goal is small amplitude high velocity movement
• Have patient focus on your nose
• Start with slow side to side motion
• Sudden thrust of 10 degrees with stop
• Watch for corrective saccade
Dynamic Visual Acuity (low tech)

- Assess patients normal vision using eye chart
  - Lowest line able to read without error
- Assist the patient to move their head at 2 Hz
- Record the difference in lines that patient is able to correctly read
- A loss of three of more lines is clinically significant.
- Computerized versions available
  - Some utilize a head tracker
  - Will randomly change size of image
Frenzel or Infrared Goggles

• Allows for observation of eye movement without gaze fixation
• Observe for nystagmus
• Down beating or direction changing nystagmus indicates central pathology
• Can assist with assessment of BPPV
King-Devick

• Paper or electronic (tablet app) versions available

• Patient reads series of numbers from left to right aloud on three different cards

• Time to perform is assessed

• Can be utilized as a preseason assessment

• Takes 2 minutes to perform
Other Timed Tasks

Cancellation Tests
• Symbols or letters

Trail Making Test
• Looks at visual attention to task
• Timed test
Benign Paroxysmal Positional Vertigo (BPPV)

- Hoffner et al, found that up to 28% of population following a mild TBI/Concussion test positive for positional vertigo
- Otoconia (crystals) become displaced and move into a Semicircular canal

**Typical complaints**
- Sensation of room spinning
- Walls appear to move
- Short duration vertigo with lingering nausea with position changes
BPPV

• Typically assessed with Hallpike-Dix and Roll Tests
• Canalithiasis: Crystals freely floating in canal
• Cupulolithisis: Crystals are adhered to Cupula

• Treatments specific to canal and form of BPPV
  • Epley Maneuver (Canalith Repositional Maneuver)
    • Utilized for Canalithiasis of Posterior Canal (+Hallpike Dix)
  • Bar-b-que Roll
    • Utilized for Canalithiasis of Horizontal Canal (+Roll Test)
  • Semont
    • Utilized for Cupulolithisis
  • Brandt-Daroff Exercises
BPPV

CRM (Epley)  image credit  Hornibrook

Bar-b-que Roll  image credit  Hornibrook
Balance Assessment: Can they stay upright?
Mod CTSIB

• Updated version of CTSIB (Foam and Dome)

• Feet together with arms at side

• Perform with eyes opened and closed on both floor and foam
  • Note CTSIB utilized UE's across chest

• Three trials for each condition

• Score 30 sec on a trial and remaining trials do not need to be completed
Sensory Organization Test

- Computerized version of Foam and Dome
- A Gold Standard for balance
- Sway referenced walls and floor utilized
- Patients stands on force plate
- Score for sway and falls are compiled and compared to age specific norms
- EXPENSIVE
Functional Gait Assessment

• 10 item test developed for patients with vestibular deficits
  • Each condition is scored from 0-3 points

• Developed to reduce some of ceiling effects noted in Dynamic Gait Index

• Requires stop watch, shoe boxes, set of steps, just over 20 feet of walking space, and test form

• Assesses gait speed, ability to adjust gait speed, ambulation with head movement, tandem ambulation, a quick turn during gait, ability to step over obstacles, walking backwards, gait with eyes closed, and ambulation up/down steps
Balance Error Scoring System (BESS)

• Designed to assist with return to play decisions following a concussion

• Requires roughly 2 minutes to complete

Supplies
• Stop watch
• Foam pad
• Written instructions
BESS

Three different standing positions with hands on hips and eyes closed

- Feet together
- Single limb stance
- Tandem (non-dominant foot in back)

- Complete on firm surface and foam

- Score number of errors per condition (up to 10/10)
  - E.g. Opening eyes, loss of balance, a corrective step, removing hands from iliac crest, lifting part of foot, flex or abduction of trunk > 30 degrees
Four Square Test

- Requires a timer and 4 single point canes

- In patients with vestibular dysfunction it has been shown reliable for assessing an individual’s ability to change direction into multiple planes

- Patient is instructed to step through the specific pattern as quick as possible
Four Square Test

Patient starts in upper left corner

- Progresses clockwise until they end up back in starting corner
- Then move counterclockwise back to starting box
Interventions: Address the Deficit
Intervention Basics

Directly address the deficits that are noted during exam

Home Exercise Program (HEP) is vital

- We use our eyes and vestibular system all day long
- Should practice HEP numerous times a day

Push to symptoms

- A “moderate” amount of challenge
- “Rule of 2”
Intervention Basics

Supplies required

• Timer
• Targets
  • Index card, business card, sticky notes, tongue depressor
Smooth Pursuits

Patients keeps head stationary while moving card.

Eyes remain on target
- Lateral
- Vertical
- Diagonal
Saccades

Utilizes two stationary targets. Patients does not move their head. Patient quickly moves eyes from first target over to second target and back to first target. Repeat.

• Patient can hold targets or they can be placed on wall
VOR x 1/ Gaze Stabilization

Target remains stationary and patient moves their head while maintaining eyes focused on target.

Target can be placed on wall or pt can hold the target.

- Head Turns (Yaw)
- Head Nods (Pitch)
How to Progress Exercise

• Progress from sitting to standing
• Vary static foot position
• Progress from solid to compliant surface
• Progress from static standing to dynamic
• Change the background
• Change the distance from target
• Combine exercise with different activities
Further progression

VOR x 2
• Head and target move in opposite directions while eyes remain focused on the moving target

2 Target/Corrective Saccades
• Set up 2 targets like you would for saccades
• Patient moves eyes to first target. Then moves head to face target. Next move eyes to second target then move head to face this target.

• Computerized programs/equipment for reaction time and visual field challenges
Exercises for Convergence

**Pencil Push Ups**
- Pt uses one or two pens
- Closest pen has target on it
- Move it towards nose until image becomes doubled. Far pen should always appear doubled while performing exercise

**Brock String**
- Pt focuses on bead on string. Should see one bead and 2 strings in distance.
- Variety of exercises which utilize string
Near Far Accommodation

• Have pt look between targets at different distances

Set up Hart Charts
• Near Far Hart (one chart on wall and patient holds a second chart)
• Patient can alternate reading letters or numbers off charts

• As patient improves add in balance or dynamic component
Add in Some Balance Activities

• Utilize different surfaces
• Vary foot position
• Think of therapy basics
Add in some balance

• Look at special tests -> What could they not perform?

Add in dynamic skills

• Walking forward/backward
• Tandem ambulation
• Side stepping
• Walk with ½ turns or full turns
• Have them bend towards floor or reach overhead
VOR Cancellation/Visual Motion Sensitivity

• Pt looks at hand/thumbs

• Moves hands and head together while maintaining focus on thumbs
Visual Motion Sensitivity

• YouTube for optokinetics or GoPro Videos
• Turn on TV
• Disco Ball in a dark room
• Have patient perform eye exercises while watching TV or videos on computer
• If clinic is near a road perform exercises in front of window as the traffic passes
Progress to Function and Exertion

Think of functional activities
• Wall ball or tossing/bouncing ball
• Bend and pick up/put down targets

Incorporate exercises for return to play
• Have pt hold a plank while performing eye exercises
• Use the Ultraslide, row machine, elliptical or treadmill while performing eye exercise
• Sports drills with a target drawn on the ball
Case Study: What would you do?
Case Study

• John is a 16 year old High School Volleyball player.

• Struck in the head by a teammate (attempting to spike the ball during a game) 10 days ago.

• Instant onset of headache, dizziness, and some nausea. He was pulled from the game by the Athletic Trainer.

Symptoms:

• Intermittent headaches, dizziness (off balance and lightheaded), difficulty with reading, blurred vision, and trouble taking notes in school.
Case Study

Results of exam

• Neck screen is clean
• Tests negative for BPPV
• Smooth pursuits are choppy and provoke symptoms
• Convergence is 5 cm from nose
• Saccades are positive for undershooting

• VOR at 2 Hz reveals significant difficulty with keeping eyes on target
• He is unable to tolerate at Head Thrust
• He completes the Mod CTSIB but has 2 falls on Condition 4
• FGA is completed and patient has path deviations with head turns and nods. He is unable to complete the full test due to symptom provocation
• What are the next steps?
Case Study

- Issue HEP for Smooth Pursuits, Saccades, VOR x1
- Assess ability to tolerate NF Hart
- Start working on gait with head movement – progress to tandem
- Standing on foam eyes closed
- Standing on foam with head movements
- Progress HEP to perform with gait, on foam, or with challenging background.
- When ready start progressing into return to play and sports specific activities
References


• https://www.cdc.gov/traumaticbraininjury/get_the_facts.html accessed Feb 6, 2018
Questions
At what time frame post-concussion should a patient be referred to a vestibular therapist?
If you suspect cervicogenic dizziness along with vestibular dysfunction, which do you treat first?
Question

Do you treat vestibular dysfunction differently in children vs adults?