Post-Traumatic Dizziness:
Considerations for Intervention after Concussion

Presented by:
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Case Study

What's with the beer?

I'm doing a case study.
Tami: History

- Was attempting to replace a light bulb in the hallway, fell backward down 10 steps and head went through dry wall. Positive LOC. 6 hours peri-traumatic amnesia. Transferred by ambulance to UC.
- CT of her head was clear. Discharged with concussion/mild TBI on valium for spasms. Later switched to Ibuprofen and tylenol for headache pain management, and still later prescribed amitriptyline.
- Reported brain fatigue and continuous daily global headache rated 0-10/10, increasing with activity.
- Positive for dizziness, tinnitus, blurred vision.
- Dizziness worsened when turning in bed. Severity 0-10/10.
Tami

- Seen at another clinic
- Treated for BPPV
- Gaze stabilization/Habituation exercises
- Balance training
  - Prone
  - Quadruped
  - Seated on stability ball
  - Standing
- At 3 weeks all goals had been met:
  1. Pt reports reduced dizziness subjective rating to 0-2/10 or lower.
  2. Pt is independent with HEP.
  3. Improved CTSIB 20 points or more.
  4. No evidence for treatable BPPV on repeat exam.
  5. Gait and balance are safe and independent with appropriate assistive device for fall avoidance.
  6. Pt demonstrates improved FOTO score x 10 points or more.
  7. Pt participates in physical therapy 40 minutes or more.
Tami

• Came to see me 4 months later reporting improved but incomplete resolution of symptoms with the previous plan of care.

• Reported an intermittent spinning/lightheaded sensation with nausea and disequilibrium. Reported feeling "wavy" or "delayed." Stated "brain doesn't keep up with my head and body." The dizziness typically lasted for minutes after rolling in bed especially to the left, lying down, sitting up, turning head to left, looking up or down, bending forward, turning rapidly, riding in a car, and when stressed or anxious. Severity ranged from 0/10 to 7/10.

• Examination was unremarkable except for Dix-Hallpike testing which indicated bilateral posterior canal BPPV. The Left posterior canal was treated with repositioning maneuvers.
Tami

- Next clinic visit 2 weeks later.
- No vertigo since the previous visit. No longer fearful of vertigo. Still may have a “wave” or “catch-up” sensation when looking down and then up or after running.
- Positional testing felt to be negative for BPPV but may have provoked some motion sensitivity.
- Instructed in habituation training but the symptoms were not felt to be significant enough for the patient to return, therefore she was discharged from vestibular rehab. She was instructed to return to the clinic if the symptoms should worsen or fail to continue to improve.
Objectives

• Compare and contrast specific vestibular impairments occurring along with concussion.
• Recognize how recovery from concussion may be influenced by concurrent injury to the vestibular system.
• Utilize appropriate examination techniques to document post-concussive vestibular impairments.
• Understand and discuss general treatment paradigms relating to specific vestibular impairments.

Disclosures: Scott Schowalter has nothing to disclose.
Concussion Definition

- Concussion is a brain injury (mild TBI, mTBI) and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces.
- May be caused by a direct blow or with an “impulsive” force transmitted to the head.
- Short-lived impairment of neurological function that resolves spontaneously but may evolve over a number of minutes to hours.
- Functional disturbance rather than a structural injury.
- May or may not involve loss of consciousness.
- Resolution of the clinical and cognitive symptoms typically follows a sequential course but in some cases symptoms may be prolonged.

(McCrory et al, 2013)
Signs and Symptoms

- **Somatic**
  - Visual impairments
  - Dizziness
  - Balance impairment
  - Headaches
  - Photophobia
  - Nausea
- **Sleep disturbance**
  - Difficulty falling asleep
  - Sleeping less than usual
- **Emotionality**
  - Anxiety
  - Lability
  - Sadness
  - Irritability
- **Cognitive**
  - Attention deficits
  - Memory impairment
  - “Fogginess”
  - Fatigue
  - Cognitive slowing

Post-Concussive Dizziness

- Peripheral causes
  - Benign Paroxysmal Positional Vertigo (BPPV)
  - Peripheral vestibulopathy
  - Cervicogenic dizziness
  - Perilymph fistula
  - Post-traumatic endolymphatic hydrops (like Meniere’s)
- Central causes
  - Vestibular migraine
  - Autonomic dysregulation (POTS)
  - Central gaze stability impairment
  - Oculomotor abnormalities
- Psychogenic causes
  - Anxiety (PTSD)

(Ernst, et al. 2005)
Anatomy--Peripheral

1. Eardrum
2. Malleus
3. Incus
4. Stapes
5. Semicircular canals
6. Auditory nerve
7. Facial Nerve
8. Vestibular nerve
9. Cochlea
10. Eustachian tube
Labyrinth, osseous and membranous
Anatomy--Central
Vestibular Cortex

A

VIP  MIP  2v  3aNv  3aHv  6  periarctuate cortex

VPS  MST  PIVC

B

posterior parietal cortex

posterior insula and temporoparietal junction

somatosensory cortex

premotor cortex

anterior insula

hippocampus

sup. temp
Post-traumatic BPPV

- Vertigo or other sense of dizziness.
- Duration seconds to minutes.
- Triggered by head position changes relative to gravity.
- May have latency of onset up to 40-60 seconds.
- May be accompanied by
  - Nausea
  - Vomiting
  - Disequilibrium
  - Difficulty walking
- May be asymptomatic in elderly and present only as balance/gait impairment.
Post-traumatic BPPV

- Prevalence can vary
  - Alsalaheen, 2010: < 5%
  - Hoffer, 2004: 28%
  - Ernst, 2005: 57%
- Remissions tend to be shorter than non-traumatic BPPV etiology. (Gordon et al, 2004)
- More likely to be bilateral (Katsarkas, 1999)
- May require repeated treatments and initial treatment success may be lower. (Gordon et al, 2004; Del Rio et al, 2004)
Gaze stability impairment

- Blurred vision or oscillopsia
- May be due to a peripheral vestibulopathy
  - Vestibular concussion
  - Disruption of peripheral or central pathways
- May report dizziness with head movement, usually velocity-dependent.
- Functional gaze stability may be impaired without evidence of pathology in any one area. (Gottshall 2003, 2010)
  - May be due to a central rather than a peripheral lesion.
- Shown to improve with gaze stabilization exercises (Gottschall 2003)
Oculomotor impairments

- Convergence—Insufficiency vs Spasm (Chan 2002; Knapp 2002)
  - May implicate injury to brainstem
  - Dizziness may be due to blurred vision or diplopia
- Saccadic pursuit impairments (Heitger 2009, Ciuffreda 2008)
  - Difficulty tracking a moving target with eyes.
Post-traumatic migraine and anxiety related dizziness

- Anxiety and dizziness/vertigo share common central pathways

- Association between migraine and anxiety-related dizziness.
  - Pathways implicated in pain and other symptom generation overlap with pathways involved with emotion and affective state. (Balaban et al 2011, Furman et al 2005)

- 41% of soldiers with mild TBI met criteria for vestibular migraine (Hoffer et al 2004)

- Those with post-traumatic migraine had significantly lower neurocognitive function compared to post-concussion patients with nonmigrainous or no headache. (Mihalik et al 2005)
Perilymphatic Fistula

- Petrous bone fractures
- Disruption of round or oval window
Cervicogenic Dizziness

- Individuals may experience injuries to the cervical spine or cervical soft tissues in addition to the head injury.
- This impairs cervical proprioception.
- The brain needs accurate information regarding head position on trunk in order to coordinate changes to posture with vestibular information.
- Dizziness will improve as the cervical pathology resolves.
Prognosis for Recovery

• Concussions in athletes typically resolve in 2 weeks or less. (Lovell 2004, Pellman 2004, McCrea 2005)
• The percentage of patients with concussion who have a more protracted recovery time varies from 10% to 30%. (Makdissi 2010)
• Lau (2011) found that dizziness was predictive of a longer recovery time (more than 21 days)
Prognosis for Recovery

• Protracted recovery more likely:
  • Younger age, 10-18 years (Iverson 2006, Lovell 2004, Field 2003)
  • Presence of amnesia (Collins & Iverson et al 2003)
  • Exertion or higher activity level (Majerske 2008)
  • Premorbid anxiety/depression (Ponsford, 2012)
  • Migraine (Mihalik 2005, Collins & Field et al 2003)
  • Sensation of “fogginess” (Iverson 2004)
  • History of more than 3 concussions (Iverson 2004, Guskiewicz 2003)
  • Female gender (Colvin 2009, Broshek 2005)
  • Loss of consciousness not predictive (Collins & Iverson et al 2003)
Examination

• Good subjective history
• Outcome measures
  • Dizziness Handicap Inventory
    • 25-item scale designed to quantify the impact of dizziness on everyday life.
    • 100-point scale, score = percentage of perceived handicap.
  • Activities-Specific Balance Confidence Scale
    • 16-item scale rating confidence in balance skills during various functional activities
    • 100-point scale, score = percentage of perceived confidence.
  • Visual Vertigo Analog Scale
    • 10 cm line, 0 = no dizziness, 10 = worst possible dizziness.
    • Rates 9 different situations that might cause dizziness.
Examination

• Neurologic exam
  • Sensory testing
  • Coordination
  • Reflexes

• Balance and gait assessment
  • Modified CTSIB (Clinical Test of Sensory Interaction and Balance)
    • Romberg on firm + Romberg on foam
  • BESS (Balance Error Scoring System)
    • Feet together, tandem, single leg, on firm surface and foam pad.
  • DGI (Dynamic Gait Index)/FGA (Functional Gait Assessment)
    • 8- and 10-item gait assessment
  • WWT (Walk While Talking) Gait velocity
    • Dual task, simple or complex
Examination

• Cervical spine screen
  • CROM
  • Assess for upper cervical instability (Mathers, 2011)
    • Alar ligaments
    • Transverse ligament (Sharp-Purser)
• Assess for cervicogenic source of symptoms
  • Cervical Torsion Test, Compression/Distraction, Palpation

• Oculomotor exam
  • Ability to smoothly track a moving object
  • Ability to move gaze rapidly and accurately from one target to another
  • Ability of eyes to converge on a target
Examination

- Peripheral vestibular function
  - Assess the VOR bilaterally
    - Head Impulse test
  - Dynamic Visual Acuity
    - Eye chart (ETDRS)
    - Note degradation of visual acuity with head oscillation.

- Positional testing to rule out BPPV
  - Dix-Hallpike (supine or sidelying) for vertical canals
  - Roll Test for horizontal canals
Examination

- Screen for perilymphatic fistula/superior semicircular canal dehiscence
  - Valsalva test

- Orthostatic vitals
  - Systolic drop > 20mm HG, plus
  - Diastolic drop > 10mmHG, plus
  - Symptomatic
  - Should have compensatory increase in pulse rate
Interventions

- Multidisciplinary approach very important.
  - Medical (Neurology)
  - Neuropsychology
  - Counseling
  - Rehab professionals (PT, OT, SLP)
- Control symptoms
  - Headache
  - Dizziness
  - Rest/recovery period between activities
- Education
  - Written handout provided at first visit was associated with markedly less anxiety after 3 months. (Ponsford et al, 2002)
Intervention Considerations

- Cognitive impairments may affect ability for pt to be compliant with home program.
  - Simple, written/illustrated instructions.
  - Exercise completion log.
  - May need family involvement.
- Exercises may be limited by other injuries and may need to be modified or postponed.
- Motion and visual sensitivity may make some activities very difficult for the patient to tolerate.
- Aerobic exercise beneficial but exertion should be limited.
  - High levels of exertion leads to worsened cognition and increased symptoms. (Majerski (2008))
  - Progression of activity should be symptom-dependent.
Interventions

- **Balance/Gait**
  - Wide base → narrow base
  - Arms out → arms crossed
  - Eyes open → eyes closed
  - Head still → head moving
  - Plain visual background → busy visual background

- **BPPV**
  - Repositioning maneuvers
  - Liberatory maneuvers
  - Habituation
Interventions

- Gaze stabilization
  - Adaptation
    - Train vestibulo-ocular reflex (VOR).
  - Substitution
    - Substitute other systems for VOR.

- Oculomotor
  - Treat convergence insufficiency with Brock String and/or pencil push-ups for habituation and to improve near point.
  - No evidence that exercise will effectively treat spasm or saccade/pursuit abnormalities.
  - However, habituation treatment may be appropriate for any dizziness symptoms reproduced by convergence or pursuit task.
    - Saccades
    - Visual tracking of moving target
Interventions

• Cervicogenic/Migraine
  • Treatment of the cervical spine (Strategic Orthopedics/McKenzie)
  • Cervical kinesthesia re-training
  • Education/referral

• Anxiety
  • Education/referral
  • Relaxation
  • Multidisciplinary approach (Dieterich & Staab 2017)
    • Cognitive/behavioral
    • Vestibular rehab
    • Medications
Effectiveness of VBRT for post-traumatic dizziness

• Significant improvements in gaze stability, balance, and gait were noted after 12 weeks of VBRT in soldiers with concussion (Gottshall, 2010) or up to 39 weeks if reporting spatial disorientation (Hoffer et al 2004).

• Subjective dizziness, balance, and gait in 84 people with concussion significantly improved within 5 weeks of starting a VBRT program in a retrospective study. (Alsalaheen, 2010)
Thank You for Coming!

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