Vestibular and Oculomotor Dysfunction: Signs and Symptoms in Pediatric Concussion

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Introduction

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No Disclosures
Objectives

1. Vestibular & oculomotor dysfunction in concussion, what do we know now?
2. Recognizing pediatric BPPV following concussion and making timely referrals
3. Vestibular rehabilitation principles
4. Questions & Answers
Not all concussions are the same

**Somatic**
- Headache
- Pressure in Head
- Neck pain
- Nausea or vomiting
- Sensitivity to light or noise

**Vestibular-Ocular**
- Vision problems
- Hearing problems
- Balance problems
- Dizziness

**Cognitive**
- Don’t feel right
- Confusion
- Feeling like in a fog
- Difficulty concentrating/remembering

**Emotional**
- More emotional than usual
- Irritable
- Sadness
- Nervous/anxious

**Sleep**
- Feeling slowed down
- Drowsiness
- Fatigue or low energy
- Trouble falling asleep

Howell et al., Acta Ped, 2016
Vestibular-Ocular

Vision problems

Hearing problems

Balance problems

Dizziness
Oculomotor System

Neurologic pathways associated with the visual system, including oculomotor function, are widely distributed throughout the brain
• Sensitive to sub-concussive head impacts

Diffuse shear injury with concussion often can produce a broad dysfunction throughout the afferent and efferent visual systems.

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Visual Symptoms

1. Light sensitivity
2. Blurry Vision
3. Double Vision
4. Eye Strain
5. Appearance of words moving on the page
6. Place loss while reading

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Convergency Insufficiency

Saccadic eye movements

Smooth pursuits

Accommodative Dysfunction

Margot Gray, PT, DPT
• Compared collegiate athletes with and without concussion
• Ages 18-24
• Rotary chair and SOT
• 87 patients with 28 having had a concussion

RESULTS
Concussed athletes had longer saccadic, visual and dual task reaction times and reduced saccadic accuracy
Vestibular System

Peripheral System
- Semicircular canals
- Otolith organs
- Connects to the central system through CN8

Central System
- Vestibular nuclei brainstem (Medulla/Pons)
- Cerebellum
- Reticular activating system
- Cortex - spatial orientation and self-motion perception
- Spinal cord

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Vestibular Reflexes

The projections from the vestibular nuclei mediate two main classes of reflexes:

1) Vestibulo-ocular reflexes
2) Vestibulospinal reflexes
Vestibular Reflexes

1) Vestibulo-ocular Reflex (VOR)

- Uses information sourced from the organs of the inner ear to generate eye movements that stabilize gaze during head movements.

- This is accomplished by the generation of eye movements that are equal and opposite to head movements.

Gaze stabilization
Vestibular Reflexes

2) Vestibulo-spinal Reflex (VSR)

- Activation of spinal motor neurons that innervate neck, trunk, and limb muscles
- Maintain balance and body orientation in the face of ongoing perturbations
- Reflexes are fast, providing compensatory movements that counteract and protect against the potentially injurious results of tripping or falling

Postural orientation
Vestibular Symptoms

- Spinning
- Tilting
- Off balance
- Lightheaded
- Motion sickness
- Blurry vision (oscillopsia)
- Rocking or swaying

Margot Gray, PT, DPT
Healthy athletes (n = 87) and athletes with sports related concussion (SRC) (n = 28)

- Rotary chair (RC), cervical vestibular-evoked myogenic potential (c-VEMP), Sensory Organization Test (SOT)

RESULTS:

- No significant difference for tests of peripheral vestibular function (RC and c-VEMP)
- Athletes with SRC had significantly worse scores on VOR cancellation gain, subjective visual vertical and horizontal variance, and all conditions of the SOT
- Concussion may alter central processing of vestibular and visual information while not affecting the peripheral vestibular organs and associated brainstem- and cerebellar-level processes
• 109 patients ages 7-20
• 28 patients (25.7%) + PVD
• Study includes non-sports related concussions
Vestibular Testing at CHCO

- Comprehensive Vestibular Evaluation
  - cVEMP and oVEMP
  - vHIT
  - Rotary Chair
  - Headshake
  - VNG (oculomotor, positional, and caloric testing)
  - Subjective Visual Vertical test

- Limited Vestibular Evaluation
  - cVEMP and oVEMP
  - vHIT
  - Rotary Chair

- Vestibular Screening
  - cVEMP and oVEMP
  - vHIT
  - Physical Therapy Vestibular Evaluation

Anschutz Campus

Telstar, Colorado Springs
Benign Paroxysmal Positional Vertigo (BPPV)

Biomechanical disorder

A displacement of otoconia (calcium carbonate crystals) from the utricle (otolith organ) to the semicircular canals in the inner ear causing vertigo or dizziness with head movements
Prevalence of BPPV in Pediatric Concussion

Most common peripheral vestibular disorder in pediatric concussion

• Prevalence between 10%-30%

Similar rates regardless of gender or age group

• Children vs adolescents

Delayed diagnosis and management- Average of 19 weeks after injury

• Increased awareness of BPPV among concussion providers could have a major positive impact on accelerating recovery
Benign Paroxysmal Positional Vertigo After Pediatric Sports-Related Concussion

Karen Reimer, MSc, BMR(PT),*†§ Vanessa Ellis, BMR(PT),* Dean M. Cordingley, MSc,*§ Kelly Russell, PhD,*¶ and Michael J. Ellis, MD, FRCSC*§¶**

- 115 patients with SRC
- Age <19 years BPPV assessment
- 10.4% were diagnosed with BPPV
- All successfully treated with repositioning maneuvers
Subjective Questioning

Dizziness is the second most common symptom in pediatric patients with concussion

Use thorough history taking as a guide for referral for suspected BPPV
1) Rotary spells "room is spinning," or "I am spinning"
2) Duration < 30 seconds
3) Associated with a head position change in relationship to gravity
   • Rolling in bed (waking up/getting up), putting on shoes, wash hair
4) Dizziness severity NOT reliable
   • Patients with BPPV did not report more severe dizziness than patients not diagnosed with BPPV
Dix-Hallpike
Refer to Vestibular Physical Therapy

If you suspect BPPV
Refer right away—do not delay!
- Accelerate recovery
- Reduce risk of development of functional vestibular disorders
Vestibular Rehabilitation and Pediatric Concussion
Vestibular Rehab is MORE than just balance training...

- Repositioning Maneuvers
  - BPPV

- Adaptation
  - Gaze stabilization
    - (peripheral dysfunction/VOR recalibration)

- Habituation
  - For dizziness that is produced because of self-motion and/or visual stimuli
Adaptation

Gaze Stabilization exercises are used to recalibrate the VOR back to gain of 1

Test/Retest:
Dynamic Visual Acuity Test

https://vestibular.org/article/diagnosis-treatment/treatments/vestibular-rehabilitation-therapy-vrt/
Habituation

Reduction in a behavioral response to repeated exposure to a provoking stimulus with the goal of reducing symptoms

Must replicate what provokes the symptoms!
Repositioning Maneuvers

BPPV

- Goal is to mechanically remove otoconia from the semicircular canal

- Selection of maneuver is determined by the location of the otoconia

- Maneuvers are designed to clear otoconia from specific semicircular canals based on the canal orientation to gravity
Oculomotor Exercises

Pursuits: tracking targets with stationary head ex: X pattern, figure 8, Trackit, tracking ball toss with stationary head

Saccades: eye movements between 2 targets with stationary head, pen and paper tasks (ex: Michigan tracking, circle the Ps)

Convergence: brock string, pencil push-ups

Habituation
Questions?
Thank You!

Vestibular testing or screening questions?

Contact us:
Vestibular@childrenscolorado.org
References


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