Seeing Through a Concussion and Other mTBIs

Michele M. Kane, OD
Edmonds and Associates
Edmonds and Associates at Wills Eye Hospital
Rothman Concussion Network

Financial Disclosures

I have no financial disclosures.

Learning Objectives

- To gain an understanding of Traumatic Brain Injuries and Mild Traumatic Brain Injuries with a focus on concussions.
- To be able to identify oculomotor dysfunction as a result of injuries to the brain.
- How to use basic optometric examination techniques to diagnose vision complications secondary to these injuries.
- To gain a better understanding of treatment options for this patient population.

Traumatic Brain Injury

- A bump, blow or jolt to the head or a penetrating head injury that disrupts normal brain function.

	Structural Imaging	Loss of Consciousness	Alteration of mental state	Amnesia	Glasgow Coma Scale
Mild	Normal	<30 minutes	Up to 24 hours	0-1 day	13-15
Moderate	Normal or Abnormal	30 minutes - 24 hours	>24 hours	>1 and <7 days	9-12
Severe	Normal or Abnormal	>24 hours	>24 hours	>7 days	3-8

Orman JA.L, Kraus JF, Zaloshnja E, et al. Epidemiology. In: Silver JM, McAllister TW, Yudofsky SC, editors. Textbook of traumatic brain injury. 2nd ed. Washington, DC: American Psychiatric Pub; 2011. pp. 3-26.

Concussion

- The most common form of a Mild Traumatic Brain Injury (mTBI)
- Complex injury with varying symptoms and recovery timeline.
- Postconcussion Syndrome : persistence of symptoms lasting weeks, months or years after the initial injury.
  - 10% of high school athletes diagnosed with a concussion experience PCS
  - 5-30% of the remainder of those who have had a concussion experience PCS
  - Risk is greater for females vs. males
  - Risk for PCS increases with age.
  - Risk increases with repeat head injuries.

Postconcussion Syndrome

- IDC-10 F07.81
  - A head injury severe enough usually result in loss of consciousness and experience 3 of the 8 following categories within 4 weeks.
    - Headaches.
    - Dizziness.
    - Fatigue.
    - Abnormal sleep patterns.
    - Inability to concentrate.
    - Difficulty with memory.
    - Irritability or aggression, unable to handle stress.
    - Anxiety, depression, emotional instability.

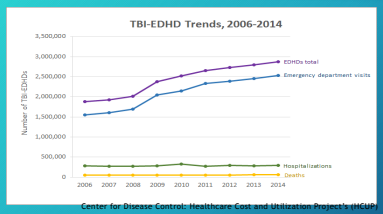
Postconcussion Syndrome

- 90% of concussions occur without loss of consciousness.
- Loss of consciousness does not directly correlate with length of recovery.
- Studies at UPMC show that +LOC may lead to a shorter recovery time.

Concussion Statistics

- In 2014: 2.87 million TBI-related injuries, hospitalizations, and deaths in the United States
  - 837,000 in the pediatric population
  - Falls account for 48% of ED visits.
- 1.7 -3 million sports or recreational related concussions annually.
  - 20% of high school athletes who play a contact sport will suffer from a concussion.
  - 50% of concussions will go unreported/undetected.
  - <10% of sports related concussions occur with a loss of consciousness.

Concussion Statistics



Center for Disease Control: Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample for emergency department visits.

Symptoms

- Headaches
- Fatigue
- Blurred Vision
- Diplopia
- Difficulty with near tasks/reading
- Photophobia (Fluorescent lights)
- Decreased depth perception
- Decrease in concentration/attention span
- Difficulty with memory and word find
- Difficulty navigating busy environments

Visual Pathway

- Retina
- Optic Nerve
- Optic Chiasm
- Optic Tract
- Lateral Geniculate Nucleus
- Striate Cortex

Visual Pathway

- Ventral Pathway
  - Detection of detail, color, size, shape, "what"
  - Parvocellular layer of LGN
  - Central retina
  - Sensitive to high spatial frequencies
  - V4, Temporal lobe
- Dorsal Pathway
  - Detection of motion "where"
  - Magnocellular layers of LGN
  - Peripheral retina
  - Sensitive to low spatial frequencies
  - V5, Parietal lobe

Visual Processing : Cerebrum

Occipital Lobe: Brodmann Area 17 (V1)

Temporal Lobe:
Object Recognition/What? (V4)

Parietal Lobe:
Where? (V5)

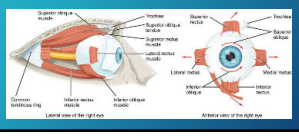
Frontal Lobe:
Frontal Eye Field, Visual Attention and Movement

Visual Processing: Cerebellum and Brain Stem

- Cerebellum
  - Eye Movements
  - Binocular Control
- Brain Stem
- Mid Brain
  - **CN III (Oculomotor)**
  - CN IV (Trochlear)
- Pons
  - **CN V (Trigeminal)**
  - **CN VI (Abducens)**
  - CN VII (Facial)

Visual Processing : Cranial Nerves

- CN II : Optic Nerve
- CN III : Oculomotor
  - Medial Rectus, Superior, Inferior, Inferior Oblique
  - Levator palpebrae superioris
  - Pupillary constriction and Accommodation
- CN IV : Trochlear
  - Superior Oblique
- CN VI : Abducens
  - Lateral Rectus



Visual Processing

- ~80% of sensory processing is affected by information received by the eyes.

Vision Evaluation

- Extensive History
  - Previous evaluations/Referral Source
  - Medical History
    - Date of injury
    - Previous mTBIs (+/- loss of consciousness)
    - Imaging/Results
  - Ocular History
  - Current Medications
  - Current Treatment Plan
  - Occupation, hobbies, activities of daily living and how those have been affected by visual changes

Vision Evaluation : Entrance Testing

- Visual Acuities
  - Monocular/Binocular
  - Distance/Near
- Pupillary Reaction
- Visual Fields
- Extraocular motility
- Color Vision

Vision Evaluation : Binocular Testing

- Cover Test : horizontal or vertical deviation of alignment
  - 3 point
  - Comitant/Noncomitant
- Near Point of Convergence
- Vergence Eye Movements
  - Base Out/Base In Step Vergence
  - Vergence facility (12BO/3BI)

Vision Evaluation: Binocular Testing

- Stereoacuity
- Worth 4 Dot +/- Suppression
- Heterophoria: horizontal and vertical
  - Von Graefe
  - Maddox Rod

Vision Evaluation

- Amplitude of Accommodation
- Accommodative facility
  - Binocular
  - Monocular
- NRA/PRA
- Fused Crossed Cylinder

Vision Evaluation

- Saccades & Smooth Pursuits
  - NSUCO Criteria (Ability/Accuracy/Head Movement/Body Movement)
- Developmental Eye Movement Test vs. King Devick Test
- Vestibular Ocular Reflex
  - Yaw, Pitch, Roll

Symptom Survey

- Convergence Insufficiency Symptom Survey
  - 15 question symptom survey
    - Never (0)
    - Infrequently (1)
    - Sometimes (2)
    - Fairly Often (3)
    - Always (4)
  - Score >15 is clinically significant.

Symptom Survey

- Motion Cognition Symptom Survey
  - Do you feel dizzy or disoriented after using your eyes?
  - Are you uncomfortable in a crowd?
  - Do you feel uncomfortable driving or riding in a car?
  - Are you light sensitive?
  - Do you get headaches at the end of the day after using your eyes?

Refraction

- Variations of when to complete this part of the evaluation.
- Trial frame vs. Phoropter
- Reliability of subjective refraction.

Vision Evaluation : Ocular Health

- Anterior Segment Slit Lamp Exam
  - Ocular Surface Disease
  - Cataracts
- Posterior Segment Dilated Fundus Exam
  - Macular changes
  - Hemorrhages
  - Post injury trauma
- Ancillary Testing
  - Fundus Photography
  - Optical Coherence Tomography (OCT)
  - Visual Field

Treatment : Glasses

- Single Vision
  - Distance Only
  - Near Only
- Lined Bifocal/Trifocal
- Progressive Addition Lenses
  - Has a patient worn them before?
  - Risks for adaptation period
- Full or partial lens occlusion
  - Binasal/Bitemporal occlusion

Treatment : Contact lenses

- Visual comfort for anisometropia
- Specialty lenses
- Black-out pupil

Treatment : Prism Lenses

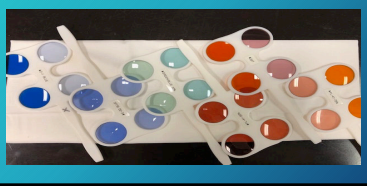
- Bends light from the base and shift images towards the apex.
- Used to move images from damaged/non seeing area of the visual system to the area of good vision.
  - Base towards area of defect.
- Used to correct for double vision (horizontal and vertical).
- Used to relax eye movements for reading and near work.
  - Base in or Base down

Treatment : Prisms

- Yoked Prism : Prism lenses of the same power oriented in the same direction over both eyes.
- Can be utilized to adjust gait and posture.
  - Base Down Prism : shifts image up, body shifts back, image appears to be father away.
  - Base Up Prism : shifts image down, body shifts forward, constricts space.
  - Base Left or Right : shifts center of gravity, used for hemispatial defects and neglect

Treatment : Filters

- Address glare, improve contrast, provide visual comfort.
- Blue Blocker options
- FL-41

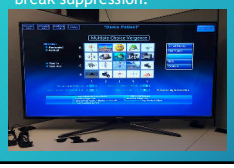


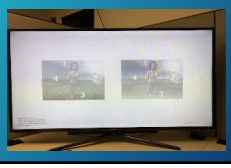
Treatment : Vision Therapy

- Office based training sessions to learn to respond and adapt to vision changes.
- Free-space exercises.
- Computer based training programs.
  - Interactive
  - Biofeedback
  - Data points to assess individual progress
- Re-establish visual motor skills needed to safely navigate through environment and complete daily activities.
- Supplemental home therapy.

Treatment : Vision Therapy

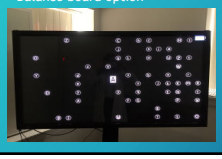
- Computer Based Orthoptic Training
- Flat Fusion, Stereopsis, Simultaneous Perception
- Monocular and binocular stimuli, liquid crystal glasses to help break suppression.

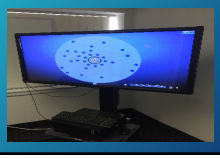




Treatment : Vision Therapy

- Visual Integration (Sanet Visual Integrator)
  - Saccades
  - Pursuits
  - Visual Memory/Processing (Auditory-visual integration)
  - Balance board option



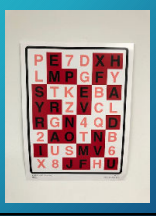


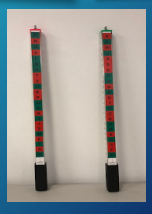
Treatment : Vision Therapy

- NeuroTracker
  - Cognitive training program used to enhance attention, executive functioning, working memory, and processing speed.
  - "Focus on the target and filter out distractions."
  - Wellness, performance, and learning.
  - Available home program.

Treatment : Vision Therapy

- Free Space Exercises
  - Coit Vectogram
  - Red/Green Antisuppression
  - Hart Chart
  - Brock String





Treatment: Compensatory Strategies

- Adjustments to computer screen
- Printed material/larger print
- Line guides
- Natural light or Desk lamp vs. overhead fluorescent light
- Patching
- Earplugs
- Frequent breaks

Treatment: Co-management

- Neurology
- Physical Medicine & Rehab
- Physical Therapy/Vestibular Therapy
- Occupational Therapy
- Speech/Cognitive Therapy
- **Psychology**
  - **NeuroPsychology**

Treatment: Return to work/school

- Frequent breaks
- Quiet work environments
- Extended time to complete tasks
- Printed documents/enlarged print

References

- Ciuffreda, K. et al. Vision therapy for oculomotor dysfunctions in acquired brain injury: A retrospective analysis. Journal of the American Optometric Association. 2008 Feb. 79, 18-22.
- Gallaway, M. Scheiman M., Mitchell, GL. Vision Therapy for Post-Concussion Vision Disorders. Optom Vis Sci. 2017 Jan,94 (1): 68-73.
- Heick, J et al. Evaluation of Vertical and Horizontal Saccades Using the Developemental Eye Movement Test Compared to the King-Devick Test. Int. Journal of Sports Physical Therapy. 2018 Aug, 13(5): 808-818.
- Perry, CJ., Fallah, M. Feature integration and object representations along the dorsal stream visual hierarchy. Frontier Computer Neuroscience. 2014 Aug 5.
- Prince C., Bruhns, M. Evaluation and Treatment of Mild Traumatic Brain Injury: The Role of NeuroPsychology. Brain Science. 2017 Aug 7(8): 105.
- Scheiman M., Wick B. Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders, Fourth Edition. Philadelphia: Lippincott Williams and Wilkins; 2014.
- The Convergence Insufficiency Treatment Trial Investigator Group. Validity of the Convergence Insufficiency Symptom Survey Confirmatory Study. Optom Vis Sci. 2009, April; 86(4): 357-363.
- Valentinos Z., Klatzky, R., Behrmann, M. Ventral and Dorsal Visual Stream Contributions to the Perception of Object Shape and Object Location. Journal of Cognitive Neuroscience. 2014 Jan; 26(1): 189-209.
- Other References:
  - Centers for Disease Control and Prevention
  - The University of Pittsburgh Medical Center Sports Medicine Concussion Center

Thank you!

Michele M. Kane, OD
michelekane@edmondsgroup.com
Drexel Hill: 610.449.2540
Philadelphia: 215.928.3450