OBJECTIVES

- Understand the incidence and prevalence of concussion/mTBI
- Define concussion/mTBI
- Recognize the cluster of symptoms that defines post-concussion syndrome
- Recognize the importance of interdisciplinary collaboration

Case Presentation—stage I

- Fell backward chasing a pop fly
- Head never hit the ground
- Concussion was the initial diagnosis
- CT scan negative
- Doctors expected him to be playing within a day or two

Concussion Defined

“a complex patho-physiological process induced by traumatic forces secondary to direct or indirect forces to the head that disrupts the function of the brain... associated with normal structural neuroimaging findings... and may or may not involve a loss of consciousness”

Centers for Disease Control

Concussion Defined

Definition of Concussion per Zurich 2009 Concussion Statement (36)

Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common factors that incorporate clinical, pathological, and biomechanical injury constructs that may be utilized in defining the nature of a concussive event.

1. Concussion may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with or without loss of consciousness, or by "acceleration-deceleration" force transmitted to the head.
2. Concussion typically results in the rapid onset of substantial impairment of neurocognitive function that resolves spontaneously.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms typically reflect a functional disturbance rather than a structural injury.
4. Concussion results in a broad set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that, in a small percentage of cases, post-concussive symptoms may be prolonged.
5. No abnormality on standard structural neuroimaging studies is seen in concussion.
Incidence and Prevalence
- 1.4 Million reported incidents of Traumatic Brain Injury (TBI) in the US every year (2004)
  - Mild TBI 70–90%
- Incidence of hospital treated mTBI: 100–300:100,000
- Projected Annual Incidence of mTBI: 600:100,000

Ankle Sprains
215:100,000

Population Characteristics
- Gender for mean number of ED visits annually for mTBI
  - Male: 57%
  - Female: 43%

Population Characteristics
- Age Characteristics for mean number of ED visits annually for mTBI
  - 0–14: 5%
  - 15–24: 38%
  - 25–34: 19%
  - 35–44: 19%
  - 45–54: 19%
  - 55–64: 19%
  - 65–74: 19%
  - >74: 19%

Pathophysiology of Concussion
- Acute Metabolic Cascade
  - Result from forces that produce axonal “stretching”
  - Initial depolarization of neuronal membranes
  - Release of excitatory amino acids
  - Hypermetabolic glycolytic state followed by vasoconstriction
  - Resultant state of metabolic depression
- Increased susceptibility to further injury

Symptoms of Concussion
- Somatic Complaints
  - Headache (86%)
  - Dizziness/Balance Deficits
  - Nausea/Vomiting
  - Sensitivity to light/noise
  - Visual Disturbance
  - Numbness and Tingling
  - Tinnitus

Causes
- SPORTS
- FALLS
Evaluation and Treatment of Post-concussion Treatment

Symptoms of Concussion

**Cognitive Deficits**
- Poor concentration
- Memory problems
- Slowed thinking
- “in a fog”

**Neurobehavioral Deficits**
- Depression
- Frustration
- Irritability/nervousness
- Drowsiness
- Altered sleep patterns
- Fatigue/lethargy

Whiplash

- Sudden flexion/extension mechanism
- Elongation and sub-failure strain
- Unique injuries to the cervical spine

**Somatic**
- Headache
- Dizziness
- Visual and auditory disturbance
- TMJ dysfunction
- Photophobia
- Fatigue

**Cognitive deficits**
- Concentration and memory loss

**Neurobehavioral**
- Anxiety
- Insomnia
- Depression

Concussion vs. Whiplash

- Similar Mechanism
- Similar Symptoms
- Lack of acute lesion with radiologic tests
- Does it Matter?

An Interdisciplinary Approach to Management of Post-Concussion Syndrome
**Evaluation and Treatment of Post-concussion Treatment**

### Initial Presentation

**Who do people report to?**
- Coach, Athletic Trainer, or parent
- Emergency Department
- Primary Care Provider
- No one

### Initial Management

**Medication**
- Rest

**Education**

### What's Important?

- **History**
- **Exam**
  - Cognitive
  - Physical
- **Imaging**
  - Indications
  - Risk factors for hemorrhage

### Predictors of Post–Concussion Syndrome

- **Duration of Amnesia** (Cantu, 2001; Collins et al, 2003)
- **3 or more concussions** (Guskiewicz et al, 2003; Collie et al, 2006; Couvassin et al, 2008; Slobounov et al, 2007)
- **Age** (Field et al, 2003; Metzl, 2006; Pellman et al, 2006; Sim et al, 2008)
- **Female Gender** (Reddy and Collins, 2009)
- **Prolonged headache and migrainous symptoms** (Collins et al, 2003; Register-Mihalik et al, 2007; Mihalik et al, 2005)
- **Exertion** (Leddy et al, 2007; Majerske et al, 2008)

### Concussion vs Whiplash

- **Initial HA intensity**
- **Duration of Amnesia**
- **History of concussions**
- **Age**
- **Female Gender**
- **Prolonged headache symptoms**
- **Exertion**
- **Initial HA intensity**
- **History of neck pain**
- **Age**
- **Female Gender**
- **Moderate acute PTSD**
- **Altered Pain Processing**

### When do symptoms of concussion become post–concussion syndrome?

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**Post Concussion Syndrome**

- HEADACHE
- DIZZINESS
- FATIGUE
- LIGHT SENSITIVITY
- DEPRESSION
- FOGGINESS
- DIFFICULTY CONCENTRATING

**Post-Concussion Syndrome**

- Definition
  - DSM–IV–TR: A clinical state in which head trauma is accompanied by 3 or more post-concussive symptoms that **persist for 3 months following injury**.
  - WHO ICD 10: 3 or more of the following: HA, dizziness, fatigue, irritability, insomnia, concentration difficulty, or memory difficulty that persist for **4 weeks following injury**.

**Treatment of Post–Concussion Syndrome**

- Education
- Medication
- Neurocognitive Therapy
- Psychological Counseling
- Graded Activity
- Neuropsychological Therapy

**Case Presentation – Part II**

- Sat out the remainder of the 2006 season
- Neuropsychological testing indicated compromised functioning
- Symptoms persisted
- Noted symptoms in daily activities
- Psychosomatic issues

**Anatomy and Physiology Review**

- The Vestibular System
Where does all this information go?

- Afferent information travels ipsi-lateral
- Vestibular Nerve bifurcates
- 2° afferents from vestibular nuclei travel to extraocular motor nucleus, spinal cord and flocculus

Theoretical Approach

- Sensorimotor disturbances in neck disorders affecting postural stability, head and eye movement control

Sensorimotor Reflexes

- Cervico-colic reflex (CCR)
- Cervico-ocular reflex (COR) or Vestibular-ocular reflex
- Tonic Neck Reflex

Sensorimotor Impairments

- Cervico-colic reflex (CCR)
- Activates neck muscles in response to stretch, maintenance of head position
- Cervico-ocular reflex (COR) or Vestibular-ocular reflex
- Assists clear vision with movement
- Tonic Neck Reflex
- Postural stability
Evaluation and Treatment of Post-concussion Treatment

Considerations for Evaluation
- Functional Impairments
- Neuromuscular Proprioception
- Oculomotor Performance
- TMJ/Cervical impairments
- Convergence Insufficiency
- Vestibular origin of symptoms

The Baseball Player
- Injury Date: 7/6/06
- Initial visit: 11/18/08
  - Nausea
  - Sympathetic Symptoms
    - Fight or Flight
  - Face, arm/leg numbness
  - Visual disturbances
  - Dizziness

Functional Impairments
- Reading/CPU work, eye strain/fatigue
- Voluminous spaces trigger
  - Stadiums/domes, Walmarts, Casino
- Eye Movements
  - Trigger
    - Looking in upper or lower quadrant

Timeline
- Initial Injury
- Noticeable positive change
- Return to baseball

Neuromuscular Proprioception
- Cervical Joint Position Error
- Balance

Oculomotor Performance
- Gaze Stability
- Eye follow

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Evaluation and Treatment of Post-concussion Treatment

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**Oculomotor Performance**

- Saccadic eye motion
- Eye Head Coordination

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**Sensorimotor Deficits -- CK**

- Cervical Joint Position Sense
- Balance
- Gaze Stability
- Smooth Pursuit
  - Specifically lower quadrant – bilaterally
- Convergence
  - Near far + smooth pursuit
- Saccadic movements

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**Treatment Overview**

- **Identified:** Oculomotor/Sensorimotor Deficits
- **Exercised:** the deficits

  **Manual Therapy:** to improve performance/tolerance to exercises
  - Test/provoke, manual therapy, re-test

  Initial frequent follow-ups, 3-5x/week

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**TMJ/Cervical Intervention**

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**Timeline**

- Initial injury: 7/6/06
- Noticeable positive change: 11/18/08
- Retraining lower visual field deficits: 12/18/09
- Return to baseball: 1/28/09
- Noticeable positive change: 2/11/09

**Notable issues with CK**

- Foot choice with single leg stance increased/decreased dizziness with eye exercise
- Altered movement patterns
  - Head tilt with rotation
  - Improved with augmented practice
- Sympathetic triggered if pushed too far

**Whiplash (WAD) vs Concussion**

- **15 y/o female soccer player**
- **MOI collision, no LOC or amnesia**
- **1° headaches and impaired concentration**
- ** Renewed symptoms 2 months later**
- **Removed from school and all activity**

**Case Study -- BB**

- **15 y/o female soccer player**
- **MOI collision, no LOC or amnesia**
- **1° headaches and impaired concentration**
- **Renewed symptoms 2 months later**
- **Removed from school and all activity**

**Timeline**

- Initial injury: 8/28/10
- Noticeable positive change: 11/24/10
- Returned to sport specific training/drills: 11/29/10
- Return to soccer: 12/6/10
- Return to soccer: 12/23/10

**Treatment Overview**

- **Identified**: Occulomotor/Sensorimotor Deficits
- **Exercised**: the deficits
- **Manual Therapy**: to improve performance/tolerance to exercises
  - Test/provoke, manual therapy, re-test
- **Initial frequent follow-ups, 3-5x/week**

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Timeline

- Initial Injury: 8/28/10
- Noticeable positive change: 11/24/10
- Returned to sport specific training/drills: 11/29/10
- PT Evaluation: 12/6/10
- Returned to soccer: 12/23/10

Conclusion

- Growing Incidence
- Long Term Disability
- Limited understanding of pathophysiology
- EARLY INTERVENTION!

Questions?

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