Concussion – An evidence based approach to optometric management

Course Description
• This course provides an overview of the current evidence-based pathophysiological mechanism of concussion and visual sequelae as well as a literature-guided direction for optometric patient management

Learning Objectives
• Describe the pathophysiological changes in concussion
• Outline the current evidence-based visual sequelae post-concussion
• Explain the current/future directions of optometry's role in concussion management

Outline
• Goals/General Outline
  o Traumatic Brain Injury
    ▪ Grades
    ▪ Pathophysiology
  o Concussion
    ▪ Definition
    ▪ What do we know?
    ▪ What do we not know?
    ▪ Challenges in diagnosis?
    ▪ Sequelae – Post Concussion Syndrome, Second Impact Syndrome, Chronic Traumatic Encephalopathy
  o Visual Problems After Concussion
    ▪ Permanent vs. Transient
    ▪ Literature review of most prominent disorders
    ▪ Future directions for the field
    ▪ How to manage in a primary vs. a tertiary care setting
    ▪ Role of Vision Therapy
• Glasgow Coma Scale (GCS) and Levels of TBI
  o GCS
    ▪ Motor Response
    ▪ Verbal Response
    ▪ Eye Opening
  o Level of TBI
    ▪ Mild
      ▪ GCS 13-15
      ▪ +/- loss of consciousness, less than 30 minutes
      ▪ Normal neuroimaging (low-field MRI/CT)
    ▪ Moderate
      ▪ GCS 9-12
      ▪ Loss of consciousness, greater than 30 minutes, less than 24 hours
      ▪ Normal/abnormal neuroimaging
    ▪ Severe
      ▪ GCS 3-8
      ▪ Coma
Jacqueline Theis, O.D., F.A.A.O.
135 Shoreline Court, Richmond CA 94804
Phone: 415-404-0557 • E-Mail: dr.jaci.od@gmail.com

- Normal/abnormal neuroimaging
  - Vegetative
  - GCS <3

- TBI Pathophysiology
  - Primary traumatic brain damage
    - Mechanical forces leads to tissue deformation AT the moment of injury
    - Direct damage to blood vessels, axons, neurons, glia, etc
    - Diffuse axonal injury (DAI)/vascular injury (DVI)
  - Focal Injury
    - Vascular (intracerebral, subdural, extradural, subarachnoid injury)
    - Axonal injury
    - Contusion
    - Laceration
  - Secondary traumatic brain damage
    - Complication of primary damage
    - Ischemic and hypoxic damage, cerebral swelling, increased intracranial pressure, infection, etc

- Concussion - Controversy over a “Definition”
  - Type of mild traumatic brain injury
  - External force or sudden movement causes rapid acceleration/deceleration of the brain tissue within the skull
  - Internal linear, translational, and rotational forces leads to a complex pathophysiological process that results in functional disturbance of brain function
  - Traumatically induced transient disturbance in brain function
    - Current definition – but emerging research and advancing technology is questioning how reversible/transient this dysfunction is

- Epidemiology of Concussion
  - CDC 2010 - 2.5million people went to ER for TBI based on ICD9 data
    - 75% mTBI
    - Underestimate since only includes those who presented to the ER and had a relevant diagnostic code (Voss)
  - Pediatric population
    - 173,285 <19yo nonfatal concussion annually 2001-2009
    - Increase from 153,375 to 248,418
  - Most common mechanism – Falls
    - Followed by motor vehicle accidents, blunt object trauma, assault/battery
  - High Risk Populations
    - Military
    - Athletes
      - 1.6-3.8million Sports-related concussion (SRC) annually
        - Discrepancy in numbers of CDC due to difficulty in research
        - Difficulties with under-reporting/diagnosis of SRC
      - 5.8% of all collegiate injuries, 8.9% of high school injuries

- Common Diagnostic Tests for Concussion for Physicians
  - Self-report Symptom Checklists
    - PCSS – Post Concussion Symptom Scale
  - Brief cognitive assessment
• Balance Tests
  - SCAT 3
  - BESS
• Computer Based Neuropsychological Tests
  - ImPACT
  - CogSport
  - Headminder
• Vision- the newest factor in concussion management
  - Emerging research points to vision as an excellent marker for acute concussion
    - King-Devick
    - VOMS
  - Lack of acceptance of visual screeners and lack of knowledge about vision in medical providers is a barrier to optometric referrals and management
    - Educating ourselves and working with general physicians/sports medicine physicians to reduce the barrier
• Why does diagnosis matter?
  - Second Impact Syndrome
    - Pathophysiology
      - Second impact prior to resolution of first concussion causes complete disautoregulation of CNS – leading to diffuse cerebral edema, increased intracranial pressure, and death
      - Mortality rate 50%, Morbidity rate 100%
  - Chronic Traumatic Encephalopathy CTE
    - Possible implications of tau protein deposition in the brain and repeat head injury
• Why is Diagnosis Difficult?
  - Challenging for even well-trained medical professionals
  - No structural neural injury on conventional neuroimaging (CT, low field MRIs)
  - Functional damage on advanced neuroimaging (high field functional MRI, MRI with diffuse tensor imaging)
    - Limited access to this equipment by patients and providers
• Concussion Management?
  - Classically
    - 80-90% of symptomatic concussions resolve within 7-10 days after injury
  - Is symptom resolution indicative of complete recovery?
  - Long term side effects/brain damage from concussion yet to be determined?
    - Is it transient?
      - More recent studies question if concussion recovery takes longer ~3-4 weeks?
• Optometry’s Role?
  - Pressing need for objective diagnostic tools for concussion assessment that are straightforward to administer
  - Current research in using eye movements and oculomotor function for sensitive and objective biomarkers of cerebral dysfunction
  - Can we track concussion with the visual system??
  - Management of Post-Concussion/Head Injury Vision Problems
    - Co-management/multidisciplinary approach to concussion
- Why vision may be key and how to prepare yourself for a concussion examination
  - Afferent Visual Pathway
  - Efferent Visual Pathway - CN III, IV, VI, PS, Symp
  - Visual Pathways and the Lobes of the Brain
    o Frontal lobe – eye movements
    o Parietal Lobe – Where pathway
    o Temporal Lobe – What pathway
    o Occipital Lobe – visual cortex
    o Cerebellum- Vestibular-ocular pathway
- Visual Attention and Visual Processing
- Literature Based Review of vision problems seen post-concussion – what we know now, and where research is heading
  o Oculomotor dysfunction
    - Vergence dysfunction
    - Convergence insufficiency
      - Difference between developmental and traumatic convergence insufficiency
    - Accommodative disorders
    - Saccadic dysfunction
    - Visual processing disorders – reduced visual processing speed
        o n=219
          - Post-season KD scores were lower (better than pre-season scores - mild learning effect
        o n=10 concussions - significant worsening from baseline 5.9 sec
        o Remove from Play/Sideline Assessment Tool
        o Requires baseline
    - Photophobia
- DEM
  o Normed for 6-13 year olds
  o Can assess visual processing speed/RAN versus horizontal tracking/binocular vision
  o Not known outside of Optometry
  o Minimal research compared to KD
- VOMS (Vestibular/Ocular Motor Screening) Assessment
    - VOMS
      - 1. Smooth Pursuit
      - 2. Horizontal and Vertical Saccades
      - 3. Convergence
      - 4. Horizontal VOR
5. Visual Motion Sensitivity
   - n=64, Age 13.9 +/- 2.5 years seen 5.5 +/- 4.0 days post SRC and the PCSS (Post-Concussion Symptom Scale)
   - 61% reported symptom provocation after at least 1 VOMS item, all VOMS items were related to the PCSS total symptom score
   - High Predicted probability for identifying concussed patients

- fMRI of Acute Oculomotor Deficits in Concussed Athletes
  - n=9, 7 days post-concussion
  - n=9, age, sex match normal volunteers
  - Fixation, Reflexive saccades, anti-saccades, memory guided saccades, self-paced saccades
  - fMRI - widespread increased activation of multiple brain areas following concussion in response to oculomotor tasks
    - Longer latency time, worse position errors, fewer number of self-paced saccades

- Post-Concussion/Head Injury Vision Problems
  - n=220 individuals with TBI (n=160) or CVA (n=60)
  - Computer based query in clinical population 2000-2003
  - Results: Majority with either TBI (90%) or CVA (86.7%) manifested an oculomotor dysfunction

- Vestibulo-ocular dysfunction in pediatric SRC
  - Retrospective review of all patients with acute SRC (presenting 30 days or less post injury) and PCS (3 or more symptoms for at least 1 month) referred to a multidisciplinary pediatric concussion program from 9/2013-7/2014
  - Methods - Clinical History, Physical, PCSS, VOD
  - VOD Complaint (dizziness, blurred vision, etc) + Sign (Abnormal pursuits, saccades, VOR)
  - Results - n=101, age 14.2 +/- 2.3 years, 76.2% with acute SRC (n=77) and 23.8% with PCS (n=24)
  - Mean duration of symptoms was 40 days for patients w/ acute SRC and VOD vs. 21 days for acute SRC without VOD.
  - Conclusions: Evidence of VOD in acute SRC and PCS. VOD was a significant risk factor for development of PCS

- TBI and Visual Consequences in a Military population
  - Retrospective analysis of eye exam records of 50 NBR and 50 BR TBI patients at PA VA Neuro-Rehabilitation Hospital
  - Results: 65% of NBR and BR TBI patients reported vision problems, Reading
complaints in 50%
  o High rates of light sensitivity, saccadic dysfunction, accommodative dysfunction and convergence insufficiency

• Role for Vision Therapy?
  o n=220 individuals with TBI (n=160) or CVA (n=60)
  o Computer based query in clinical population 2000-2003, selected those who completed optometric VT program TBI (n=33), CVA (n=7)
  o Results: 90% of TBI and 100% with CVI had treatment success
  o Marked/total improvement in at least 1 primary symptom and at least 1 primary sign
  o Improvements remained stable at retesting 2-3 months later

• Visual Consequences of Concussion in Sport
  o Return to Play
  o Return to Learn
    ▪ Visual Impact Off the Field

• Optometric Management
  o Primary Care
    ▪ Vergence (Ranges, NPC, Facility)
    ▪ Accommodation (NPA, Facility)
    ▪ DEM
    ▪ Crowding (crowded acuity symbols)
    ▪ Prescription glasses
    ▪ Focusing/vergence issues
    ▪ Sunglasses
    ▪ Reassurance
  o Tertiary Care - PCS
    ▪ Comprehensive Binocular Vision Assessment
    ▪ Visual Perceptual Skills Assessment
    ▪ Vision Therapy
    ▪ Vestibulo-Oculomotor Therapy

• Cases – Acute Concussion
  o 1) 18 year old male with baseline oculomotor examination pre-concussion
    ▪ Post-concussion patient had convergence insufficiency, vergence dysfunction, saccadic dysfunction, asymmetric accommodative insufficiency, and photophobia
    ▪ Patient seen at 48 hours, 1 week, and 1 month post concussion - all post-concussion binocular disorders returned to his baseline within 1 month
  o 2) 12 year old male post-concussion (x2) complaints of blur, photophobia, fatigue with reading
    ▪ Post-concussion - accommodative insufficiency, convergence insufficiency, inability to focus through his age-appropriate hyperopia
    ▪ Self resolution 6-8 weeks later
  o 3) 19 year old female post-concussion complaints of blur with reading, unable to pass her ImPACT testing
    ▪ Post-concussion - accommodative insufficiency
- Self resolution 8 weeks later