

## Mild Traumatic Brain Injury

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## Mild TBI

- Most prevalent TBI
- Often overlooked at time of injury
- 15% develop longstanding (>1yr) symptoms
- Post-concussive syndrome

## Mild TBI: Cause

- Forceful motion of the head or impact
- Brief change in mental status
  - Confusion, disorientation, amnesia
    - Anterograde and retrograde amnesia
      - No loss of autobiographical information
- Loss of consciousness for < 30 minutes

## Symptoms

- Lability (irritability, easily tearful)
- Depression
- Seizures, Fatigue, Headaches, Visual Disturbances, Memory Loss, Poor Attention/Concentration
- Sleep Disturbance
- Dizziness/Loss of Balance
- Emotional

## Concussion

- From Latin *concutere* “to shake violently”
- Most common type of traumatic brain injury
- Epidemiology
  - 6 per 1000 people
  - Sports injuries, bicycle accidents, MVAs, falls, military (combat and civilian) (IEDs)

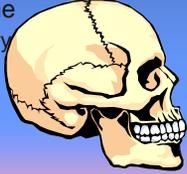
## SECONDARY INJURY

Paramount to therapy

- **Avoidance of hypotension and hypoxemia**
- Incorporate other maneuvers to avoid increased intracranial pressure (ICP) and optimize cerebral blood flow

## Classic Concussion

- Transient loss of consciousness
- Normal head CT
- Nausea, vomiting, and headache
- Post-concussion syndrome
  - Amnesia for events of injury
  - Memory difficulties
  - Dizziness
  - Nausea and vomiting
  - All lasting days to weeks



## Skull Fractures

- Clinical signs
  - Retroauricular ecchymosis (Battle's sign)
  - Periorbital ecchymosis (raccoon eyes)
- Complications
  - VIIth nerve palsy
  - CSF leaks
    - Rhinorrhea – anterior skull base
    - Otorrhea – mid-skull base
- NG Tubes ???



## Concussion: Grading Scales

- Grade I
  - Amnesia < 30 min
  - Confusion, No LOC
  - Symptoms < 15 min
- Grade II
  - Amnesia > 30 min, LOC < 5 min
- Grade III
  - Amnesia > 24 hr, LOC > 5 min

## Concussion: Symptoms

- Headache
  - Migraine, tension-type
- Loss of motor coordination
  - Ataxia, imbalance, diplopia
- Seizures
  - Early: not predictive of epilepsy
    - "convulsive syncope" – brief immediate sz
- Cognitive
  - Confusion, difficulty focusing (perplexed)

## Mechanisms

- Rapid acceleration/deceleration
- Impulsive force: head strikes immovable object/ rotational force
- Blunt trauma
- Explosive force

## Blast-Related TBI

- Improvised Explosive Devices
  - Signature injury of OEF and OIF
  - Homemade to sophisticated weaponry/high grade explosives
- 65% of severe TBI is explosion-related; 1/2 of all TBI is non-combat related
- Mild TBI probably underdiagnosed

## Blast-Related TBI

- Blast overpressure wave – vacuum – second positive pressure wave – return to atmospheric pressure
- Brain within the rigid cranial vault
  - Shear forces
  - Rapid accel/decel of the head
  - Tissues at risk: of different density
    - Lung, GI tract
    - White and gray matter of the brain/fluid and cell bodies

## Blast Trauma

- Clinical markers, GCS, duration of amnesia, ongoing headache
- “dazed,” seeing stars, brief disorientation: Due to blast exposure or shock of the event
- Initial CT normal: deterioration over 48 hours
  - Consider MRI

## Mild TBI in Veterans

- Cross-sectional study of 2235 OEF/OIF veterans who had left combat theaters by Sept 2004
  - 12% reported history consistent with mTBI on the 3-Item Brief Traumatic Brain Injury Screen
    - Alteration, but not loss of consciousness
  - 11% screened positive for PTSD

## TBI in Veterans

- PTSD - improbable if amnesic for the event
  - However, affective responses may be encoded at an unconscious level
  - Reconstruction of events from secondary sources may influence the development of sx
  - Medical procedures at the scene, sights are psychologically traumatic

## TBI in Veterans

- Military combat: a series, not a single, life-threatening or traumatic event
- PTSD more often associated with mild than severe TBI
  - Limited encoding of event may be protective

## Treatment in the Military

- Mild TBI not reported as a cause of psychiatric evacuation during OEF and OIF (emotional disorders have)
- Subtle deficits in performance in a highly demanding occupation; self and others at risk
- Reluctance to self-report mental health problems

## Outcome

- Rehabilitation for functional recovery
- Social support
- Younger age beneficial
- Disfigurement, chronic pain, ear/vestibular damage and psychiatric illness complicate recovery
- Sequelae of TBI and psychological trauma overlap and are hard to distinguish

## Outcome

- mTBI worsens executive deficits associated with PTSD
- Memories may be less amenable to effective self-management
- mTBI: damage to amygdala: emotion/fear center and pre-frontal cortex: "check" inhibitory center

## VA Hospitals

- DoD and VA healthcare screening
- Optimal context for healthcare delivery
  - Primary care, mental health, rehabilitation centers
- Compensation and pension issues

## Anatomy

- Vulnerable areas of the brain
  - Midbrain/diencephalon
  - Brainstem
  - White-gray junction
  - White matter tracts
    - Corpus callosum
  - Temporal and frontal lobes
    - Personality change, cognitive function, seizures

## Pathophysiology

- Drop in cerebral blood flow
- Excitatory neurotransmitters
  - Glutamate
  - Calcium influx: hyperexcitable neurons
  - Hypermetabolic state: elevated glucose needs
- Alteration in the BloodBrainBarrier
  - Vulnerable to hypoxia, ICP
- Diffuse axonal injury

## Concussion: Pathoanatomy

- Original theories
  - Loss of physiological/metabolic function without structural change
- Current: cellular and structural damage
- Neuroimaging
  - Conventional: normal
  - Advanced MRI: abnormalities

## Mild TBI: Definitions

- LOC < 30 minutes
- Post-traumatic amnesia <24 hours
- Glasgow Coma Scale >12
- Mild TBI
  - May include SDH, ICH, EDH

## Diagnosis

- Initial duration of LOC, amnesia
- Neuropsychological tests
  - Athletes: baseline scores cf post-impact
- Symptoms of concussion/ Mild TBI

## Diagnosis in Athletes

- Standard Assessment of Concussion
  - Questions of orientation, memory and concentration
  - Decline immediately post impact as compared to baseline
  - Improvement in 15 minutes and further normalization in 48 hours
- Rec: symptom-free for 7 days prior to return to play

## Diagnosis

- Balance, ability and reaction time
  - Visual and vestibular systems
  - Romberg, finger-nose-finger, rapid alternating movements
  - Stances on firm and foam surfaces
- Eye movement
  - Single digit numbers on test cards
    - Assesses eye movement, attention

## Recommendations for Athletes

- American Academy of Neurology

## Caution !!!

- Glasgow Coma Scale < 15 (nl)
- Focal symptoms or findings
- Persistent headache, vomiting, increasing confusion, seizures, unequal pupil size
- Confounding factors
  - Intoxication
  - Age > 60 or < 16
- “Talk and die”

## Cranial Imaging

- A normal neurological examination doesn't ensure absence of an intracranial lesion
- Skull fracture may dissipate impact energy
  - Depressed or basilar skull fractures may be predictive
- If 16 – 65 yo, no external injury or basilar skull fx, normal exam: need for NSG is <1%

## Advanced Imaging Techniques

- MRI with GRE
  - Detects microbleeds
- Diffusion Tensor Imaging
  - Shear injury to white matter tracts
- PET Scan / MRI Spectroscopy
  - Measures brain metabolites

## PTSD

- Symptoms may be identical
- Symptoms persist for months/years following injury
- Trauma, especially to the vulnerable frontal/temporal lobes may make cognitive dysfunction more likely/identifiable

## Multiple Impact

- “Dementia pugilistica”
- “Second-impact” Syndrome
  - Rare: second mild injury in children – massive cerebral edema
- Traumatic encephalopathy
- “sub-concussive” injury: soccer heading the ball

## Prevention

- Mechanical
  - Seat belts, airbags, helmets, stair rails, thin/flat shoes with hard soles
- Athletes
  - “Head Impact Telemetry System” placed in helmets
  - Barring head-down tackles or “spearing”

## Prevention

- Snowboarding and skiing
  - Helmets: facial and soft tissue injury
- Contact sports
  - Mouthguards role in dental and orofacial injury
- Equestrian, cycling, motor sports
  - Helmets

## Treatment

- Activation database guided EEG biofeedback
- Rest/ Attend to sleep-wake cycles
- Gradual return to prior activities
  - Exacerbation of symptoms with exertion
- Temporary Rx of depression, insomnia

## Treatment

- Observation for 2 hours
- Discharge to care of a responsible person
  - Need to awaken at night

## Treatment: Medications

- Mild analgesics
  - Acetaminophen preferred re hemorrhage
  - Beware “medication overuse” headache
- Avoidance of drugs/alcohol
- Meclizine, promethazine and vestibular exercises for dizziness
- HA prophylaxis
  - Topiramate, calcium channel blockers, steroids

## Post-Concussion Syndrome

- No symptom resolution for months/years
- HA, dizziness, fatigue, anxiety, memory and attention, sleep, irritability
  - Case series: HA and dizziness as high as 90% at 1 month and 25% at 1 year
  - Countries with low litigation rates have low rates of postconcussive disability
- Relationship to PTSD

## Postconcussive Syndrome Current Status

- Discrepancy between somatic/cognitive “subjective” complaints and “objective” findings
- Clear definition of concussion is elusive
  - Mildest form of TBI

## Cumulative Effects

- Severity of symptoms may worsen even if second injury is years afterward
- Neurophysiological changes
- Psychiatric disorders and long-term memory dysfunction
- Alzheimer's Disease

## Cognitive Decline

- Observational studies
  - Association between repeated sports concussions and late-life cognitive decline
- Tau positive neurofibrillary tangles in football players and beta amyloid deposition in boxers
  - Australian football: risk of concussion 15x American football but studies do not support these observational studies

## Dementia Pugilistica

- Chronic Encephalopathy
  - Boxers
    - Most are unaffected
    - ?genetic risk such as ApoE genetic markers
    - Associated risk-taking behavior, alcohol use
  - Parkinsonism, speech and memory problems
  - Tremor, inappropriate behavior