



## Clinical Aspects of Traumatic Brain Injury (TBI)

**GARY M. ABRAMS M.D.  
SAN FRANCISCO VAMC  
UCSF**

---

---

---

---

---

---

---

## Outline

- Classification and measuring TBI
- Mechanisms of damage from TBI
- TBI sequelae and Post-Concussion Syndrome
- Mild TBI and Behavioral Health

---

---

---

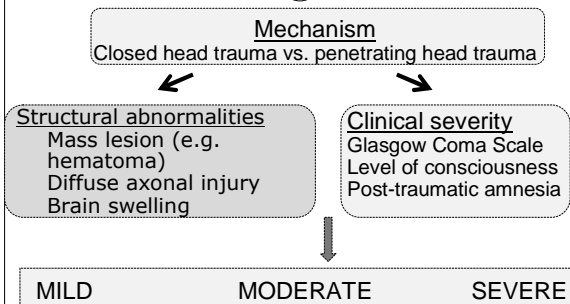
---

---

---

---

## Classification of TBI



---

---

---

---

---

---

---

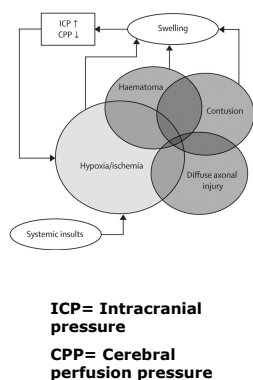
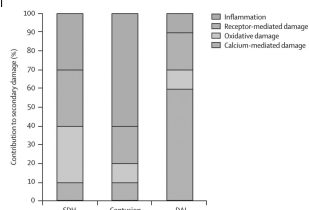
## Measuring TBI

### Grades of TBI

Mild (Grade 1) "concussion"	Moderate (Grade 2)	Severe (Grade 3 & 4)
Altered consciousness < 30 minutes "Normal" CT/MRI	Altered consciousness < 6 hours Abnormal CT/MRI	Altered consciousness > 6 hours Abnormal CT/MRI
Glasgow Coma Scale 13 - 15	Glasgow Coma Scale 9 - 12	Glasgow Coma Scale < 9
Post-traumatic amnesia < 24 hours	Post-traumatic amnesia < 7 days	Post-traumatic amnesia > 7 days



### The Mechanisms of Damage from TBI



Maas et al, Lancet Neurology, 2008

## Blast Injury

### Blast Injuries – 4 types

**\*Primary** – Overpressure of "blast wave" – ear, lung, GI

**Secondary** – flying debris

**Tertiary** – thrown into stationary objects or structural collapse

**Quaternary** – Any injury due to other mechanisms - e.g. thermal, burns, toxic inhalation, etc.



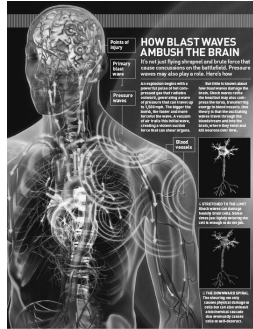
Blast wave

- High pressure shock wave
- Blast wind

DePalma et al, NEJM 2005;352:1335-42

## Blast-Related TBI

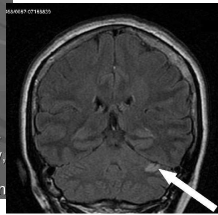
- Mechanism of Injury
  - Acceleration of the head
  - Transmission of pressure waves across skull
  - Propagation of waves via thoracic mechanism
- Cernak (*J Trauma*, 1999)
  - Blast waves ripple through thorax via blood vessels
  - Oscillations of vessels are transmitted to the brain causing damage to adjacent neurons



Hagerman, Pop Science, 2008

### Primary Blast Injury: A Case Report of SGT B

- 50 y/o SGT in Iraq walking back to quarters
- Explosion hit the ammo area of their own base
- Sgt B – crouched behind a five inch thick cement bunker with vest and helmet
- Exposure to three hours of explosions – 10/2006
- Three episodes of “having her bell rung” concurrent with “chest hurt” – once when she peered outside as a new explosion occurred
- Did not fall or hit her head at any point
- Immediate aftermath –
  - Two weeks of headache, dizziness, balance problems, nausea/vomiting – treated initially for dehydration d/t vomiting; also insomnia, anxiety, nightmares
  - Gradually felt better, remained at admin position



French and Vanderploeg, 2007

## Neurological Impairments in Moderate/Severe TBI at 1 month

Deficit	Percentage (%)
Cognitive disability	60-90
Paralysis/Weakness	60
Slurred speech	50
Cranial Neuropathy	30
Swallowing problem	30
Lack of coordination	10
Visual deficits	6



www.healthline.com

## Treatment Issues - Cognition

- Attention
- Perception
  - Auditory
  - Visuospatial
- Memory
  - Visual learning
  - Verbal learning
- Executive Function
  - Planning
  - Initiation
  - Hypothesis testing
  - Self-regulation
- Intelligence
- Language

### Cognitive pharmacology

- Avoid phenytoin
- **Attention and speed of processing**
  - Methylphenidate and donepezil
  - *option* - D-amphetamine; amantadine
- **Memory** deficits
  - Donepezil
  - *option* - methylphenidate
- **Executive function**
  - Bromocriptine?
- Methylphenidate and amantadine recommended for general cognitive deficits

J Neurotrauma, 2006

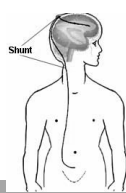
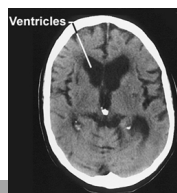
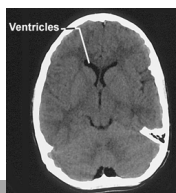
## Treatment Issues - Behavior

- Disinhibition
- Impulsiveness
- Aggressiveness
- Irritability
- Lability; Euphoria
- Paranoia
- Sexual Deviation
- Passive; Indifference

- Improvement tends not to occur after 2 years
- Treatments
  - No established drug treatment for affective disorders, anxiety, or psychosis
  - Behavioral modification
  - Psychotherapy

## Hydrocephalus

- Found in 2/3 of patients with mod/severe TBI
- Associated with worse outcome
- Treatment with CSF shunting can improve function



## Diagnosis of Mild TBI

- Obligatory criteria
  - **A credible mechanism of injury\***
  - **Craniofacial impact\***
- Major criteria
  - **Amnesia for blow\***
  - **Disordered awareness\* not necessarily with LOC**
  - **Finite PTA\***
  - GCS score <15
  - Impact seizure
  - Initial vomiting with headache
  - Binocular diplopia
  - Central vertigo
  - Focal CNS or cranial nerve signs
  - Clinical signs of basilar skull fracture
- Non-specific criteria
  - Perception of being dazed at time of injury
  - Headache, dizziness, blurred vision, tinnitus, photo- and phonophobia, fatigue, disordered sleep
  - Cognitive-behavioral symptoms
  - Neuropsychological test findings.

\*Minimum criteria for retrospective diagnosis

Rees, Arch PM&R, 2003

## ACRM/VA Definition of TBI

- Traumatically-induced physiological disruption of brain function as demonstrated after an event by at least one of the following:
  - (1) any period of loss of consciousness
  - (2) any loss of memory for events immediately before or after the event,
  - (3) any alteration in mental state at the time of the event, for example feeling dazed, disoriented, or confused
  - (4) a focal neurological deficit or deficits that may or may not have been transient, for example loss of coordination, speech difficulties, or double vision.

## Post-Concussion Syndrome (PCS)

- Post-concussion syndrome is a set of symptoms that may follow a mild TBI:

Poor concentration	Headache
Memory difficulty	Anxiety/depression
Intellectual impairment	Dizziness
Irritability	Blurred vision
Fatigue	Light/sound sensitivity

- May appear up to 2 weeks post TBI

- Most patients with PCS make a complete recovery in 3 months
- Chronic problems in 15-20%; may persist ≥ 1 year

## Post Concussion Syndrome (PCS)

- PCS – “neurogenic” vs. “psychogenic”
  - Brain imaging, EEG, etc. abnormalities are non-specific
  - PCS symptoms are seen in somatization disorders, depression, or PTSD
  - Cultural differences; litigation
- Limited studies examining interaction of TBI and anxiety/depression or PTSD.

### PTSD symptoms

Flashbacks

Recurrent experiences

Easily startled

### PTSD & PCS symptoms

Poor concentration

Depression

Irritability

Memory problems

### PCS symptoms

Headache

Nausea/emesis

Dizziness/Vertigo

Diplopia

Warden, J Head Trauma Rehabil, 2006

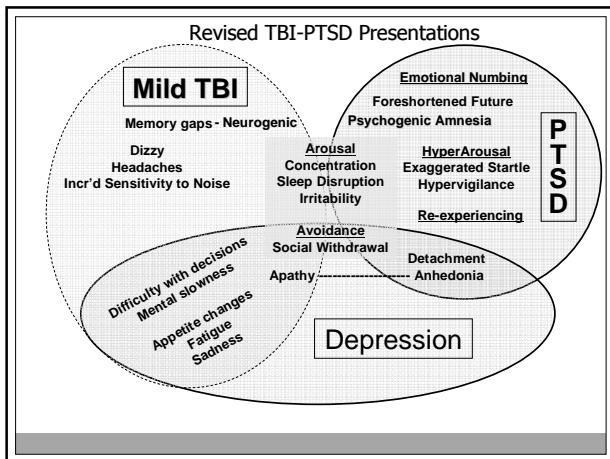
## Mild Traumatic Brain Injury in U.S. Soldiers Returning from Iraq

Charles W. Hoge, M.D., Dennis McGurk, Ph.D., Jeffrey L. Thomas, Ph.D., et al *N Eng J Med* 2008;358:453-63

- 2525 Iraq vets –
  - 15% reported injuries c/w mild TBI
  - 1/3 of mild TBIs reported loss of consciousness (LOC)
- 44% of vets with LOC met criteria for PTSD
- Mild TBI was associated
  - poor health
  - high somatic and post concussive symptoms
- When adjusted for depression and PTSD –  
**headache** was the only significant association with TBI

## Mild TBI - Headache

- Common - 25 to 78% of TBI
- Prevalence and duration is greater in mild vs. severe TBI
- In 126 OEF/OIF vets identified by the VA TBI screen and confirmed mild TBI (Ruff et al. *J Reh Res Dev*, 2008)
  - Headaches were more likely to be seen in those with neurocognitive deficits from TBI (93% v 13%)
  - mTBI vets with neurocognitive deficits experienced a greater # of blasts and ≥ 1 episode of LOC
  - Headaches were more likely to have features of migraine
    - Intense, pulsating, unilateral, GI symptoms;
    - Sensitivity to light, sound, activity
  - These vets were also more likely to have PTSD and sleep disturbance
- No difference in headaches after mild TBI vs post-orthopedic injury (Stovner et al, *Eur Neurol*, 2007)




---

---

---

---

---

---

---

---

**Summary**

- TBIs damage the nervous system via multiple mechanisms - blast exposure may be unique
- Most TBIs during the OEF/OIF conflicts are mild TBIs and have been associated with blasts
- Cognitive-behavioral symptoms are common in TBIs of all severities. Treatments are limited.
- The distinction between PCS and other behavioral health problems is unclear
- Better understanding of mTBI will require better methods of diagnosis

---

---

---

---

---

---

---

---