Understanding Blast Injury

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Disclosures
Abdullah Bin Zahid
Intellectual property related to
- Concussion and brain injury assessment
- Treatment of intracranial hemorrhage

Uzma Samadani
Intellectual property related to
- Concussion and brain injury assessment
- Assessment of dementia after brain injury
- Treatment of intracranial hemorrhage

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- USA Football
- Other

Different types of Head Injuries

• Penetrating TBI
  - Caused by a foreign object
  - Physical disruption of glial and fiber tracts
  - Hypoperfusion and ischemic cascades
  - Can be prevented by wearing protective gear

• Closed TBI
  - Usually caused by brain motion/deformation
  - Usually caused by falls, accidents, sports injuries
  - Can be prevented or reduced with the use of a helmet.
  - If “mild”, it is labelled as “concussion”

• Blast TBI
  - In mild cases: Prolonged symptoms that mirror that of other head injuries
  - Due to global oxidative stress and compromising the integrity of the BBB
  - Maybe misdiagnosed for PTSD
  - In severe cases: Early onset of global cerebral edema, pronounced vasospasm, and pseudoaneurysms
  - Isolated blast resemble neurodegenerative diseases
  - No effective prevention method

Mechanism of the Injury

• The Primary Blast – Shock wave
• Secondary Blast – Flying debris
• Tertiary Blast – Acceleration/Deceleration Forces
• Quaternary Blast – Severe Blast related Trauma/Other resulting injuries
What just happened?
Some people with brain injury were never “hit” in the head...

Schematic diagram of the mechanisms of blast-related traumatic brain injury.


Neither imaging (CT or MRI scan) nor level of consciousness tell the whole story

Screening For Injury after Blast: Symptoms, Signs

Primary Blast
- Mechanism still is unclear
- Initial shock waves from detonation site (Depends on Peak Pressure)
  - Creates a negative pressure system
  - Causes damage to neuronal synaptic junctions
  - Amplification
- Other Factors (Distance, Type, Location, etc)
- Other possible mechanisms

Molecular pathways

CT showing a small contusion after a gun shot to patients helmet.
- Grade 3 concussion
• CT of soldier with a helmet who sustained a blast injury.
• Helmet deflected shrapnel – no other mechanism of injury.

Screening after blast injury

• Military Acute Concussion Evaluation (MACE)
  • The Sport Concussion Assessment Tool (SCAT3) is the equivalent assessment of mild TBI in non-military personnel with sports concussion.

• Automated Neuropsychological Assessment Metrics
  • Computer-assisted cognitive testing; more useful if baseline is compared with tests after mild TBI.

Screening after blast injury – Con’t

• Eye tracking (can be automated)
  • Promising as a clinical adjunct to assess blast-related and non-blast-related mild TBI.

• Balance testing (can be automated)
  • Balance disturbance results from vestibular and otolith dysfunction;
  • useful in the assessment of blast-related and non-blast-related mild TBI.

• Endocrine testing
• Genetic testing

Screening after blast injury – Con’t

• CT and MRI
• Diffusion tensor imaging
• PET and functional MRI
• Biomarkers
  • GFAP, UCH-L1,
  • NEFH, and VEGF-A
• Blast dosimeters

Current Research: Overview

• 5 year outcomes with patients who’ve experience Blast related head injuries.
• Evaluation of white matter abnormalities using DTI scanning
• Structure of the study
  • Cohort n = 94 (44 military controls with no confounding variables)
  • Following injury patients were evaluated in Germany and then in the United States
  • Clinical outcomes at 1 year post injury predicted 5 year clinical outcomes
Early Clinical Predictors of 5-Year Outcome After Concussive
Blast Traumatic Brain Injury

50 subjects — enrolled at time of injury

- 5 years later: significant difference in PTSD, depression, anxiety, and sleep impairment
- More than 2x as many blast TBI subjects sought help from a mental health professional

Current Research
- Studies to look at the long term outcome of patients with bTBI
  - N=94 (44 were military controls with no confounding factors)
  - Based on a neurocognitive tests (GOS-E, NBSS, Verbal Fluency, etc)
  - 92% certainty of 1 year predictors

5-Year Clinical Predictors of 5-Year Outcome

- Use of Diffuse Tensor Imaging (DTI) to detect abnormalities in white matter
- Divided Brain into 78 regions based on computer software

Figure 4. One Year Predictors of 5 Year Global Outcomes

- One year predictors on 5 year imaging
Strengths and Limitations

• Importance
• Strengths
  - Observational, Longitudinal study design
  - Blinded Clinical Personnel
• Weaknesses
  - The small cohort of subjects
  - Demographics
  - No isolated Blast subjects *

Diffusion Tensor Imaging Comparing TBI and PTSD

The areas with abnormal white matter tracts in PTSD subjects are colored.

Eye tracking

• Attempts to measure brain function
• Functional derangement precedes structural change
• Eye tracking device: 500Hz infrared camera

Research at Hennepin County Medical Center

• Eye movement tracking while subject is watching a film clip is a novel method to detect brain injury.
• Question: Can automated eye tracking performed while viewing a short film clip detect blast brain injury?
Participants

- Patients: Subjects who suffered a natural gas explosion
- Comparison: Normal healthy controls without a history of TBI

What now?

- Avoid re-injury
- Neck strengthening
- Balance, visual training
- Sports
- Peer-support
- Avoid risk factors for substance abuse
- Avoid risk factors for depression/suicidal ideation
- Parent connectedness
- Teacher caring
- Connectedness to other nonparental adults
- School safety

References