Traumatic Brain Injury 101: An overview

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Big Picture Outline

I. Neuroanatomy and neurophysiology

II. Defining Brain Injury
   I. Acquired Brain Injury (ABI) versus Traumatic Brain Injury (TBI)
   II. Severity of injury classification
   III. Mechanism of injury
   IV. Primary and secondary injuries

III. Common Sequelae after TBI and trajectory

IV. mTBI (Concussion) – myth versus fact

II. Defining Brain Injury

I. Acquired Brain Injury (ABI) versus Traumatic Brain Injury (TBI)
II. Severity of injury classification
III. Mechanism of injury
IV. Primary and secondary injuries
Definitions – TBI and ABI

- Traumatic Brain Injury (TBI) is caused by a bump, blow, or jolt to the head or penetrating head injury that disrupts the normal function of the brain.

- An acquired brain injury (ABI) is an injury to the brain, which is not hereditary, congenital, degenerative, or induced by birth trauma. The injury results in a change in neuronal activity, which affects the physical integrity, the metabolic activity, or the functional ability of nerve cells in the brain. It can be considered the umbrella definition for TBI but also includes:
  - Stroke
  - Tumor
  - Anoxia/Hypoxia
  - Infection

ABI is an umbrella term

TBI statistics across the lifespan – CDC 2013

- 2.8 million/yr injured
- 2.5 million/yr seek emergency care
- 282,000/yr are hospitalized
- 50,000/yr die with TBI
- 80,000/yr result in long-term disability
- 5.3 million Americans with TBI disability
- Up to 6.5 million Americans with TBI
Leading cause of TBI by age

Total incidence between 2006-2010

- Motor Vehicle/Traffic
- Falls
- Assault
- Struck by/Against
- All other Causes
- Unknown

Mechanism of Injury

- Penetrating vs. Non-Penetrating "closed" injury
- Closed-head injury biomechanics:
  - A. Deformation – Direct impact can distort skull injuring underlying brain tissue
  - B. Contact – moving brain strikes inner surface of skull
  - C. Rotational – nonlinear & rotational forces cause acceleration or deceleration of brain tissue

Coup-Contrecoup injury
Inertial forces can result in stretching and breaking (shearing) of brain tissue (axons). A complex set of events is set in motion at the cellular & subcellular level, involving release of neurotransmitters.

Pathological effects

- **Primary injury – Anatomic injuries**
  - Occur upon impact and include:
    - Skull fractures
    - Contusions
    - Hematomas
    - Hemorrhages
    - Injury to Axons and blood vessels

- **Secondary injury – Metabolic injuries**
  - Occur following cascade of events after tissue damage or as result of the consequences of mass effect (e.g., hematomas)

Determining Severity

<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
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<tr>
<td><strong>Eye opening</strong></td>
</tr>
<tr>
<td>Spontaneous...4</td>
</tr>
<tr>
<td>To pain...2</td>
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<tr>
<td>Not open...1</td>
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Total score = E+V+M
Severity Classification

Mild
- Normal or abnormal imaging
- Loss of consciousness (LOC) 0-30 min
- Glasgow Coma Scale (GCS) 13-15
- Post-traumatic amnesia (PTA) <24 hours

Moderate
- Normal or abnormal imaging
- LOC >30 mins & <24 hrs
- GCS 9-12
- PTA >24 hrs & <7 days

Severe
- Normal or abnormal imaging
- LOC >24 hrs
- GCS 3-8
- PTA >7 days

Summary
- TBI definition
- Penetrating or non-penetrating injury
- Mechanisms of injury vary
- Primary and secondary injuries
- Severity indicators to help understand outcomes