Head Injury &
Traumatic Brain Injury (TBI)
8 million/yr in US, 1.5 million serious, 500,000 hospitalized, 100,000 die, 90,000 disabled, 2,000 end up in vegetative state (unconscious, involuntary functions only)
Traumatic brain injury (TBI) is the cause of death in ¼ of all accidental deaths, ½ of all traffic fatalities

More Head Injury Stats:
• 2-3x more males than females
• peak ages 18-24 & over 75
• 20% of those who die from head injuries don’t have a skull fracture; skull fracture is not a good predictor of outcome unless it is depressed
• in 2/3 death results from excessive movement of the brain in skull

Causes of Head Injuries
• 50% in motor vehicle accidents
• 21% in falls
• 12% assaults & violence
• 10% in sports accidents
• 7% other (lightening strike, electric shock)

Types of Injuries
• Closed head injury (CHI)-skull relatively intact; brain injured by excessive movement within skull
• Concussion - transient neurologic dysfunction (altered consciousness or loss of consciousness (LOC)), but no brain damage visible on CT scan
• BUT: re-injury before recovery is particularly dangerous and may even be fatal!
• Contusion - bruising of brain (surface blood vessels broken, tissue swells)
• Penetrating injury or laceration - brain tissue torn or punctured (by bullet, bone fragment)

Cranial Injury
• Trauma must be extreme to fracture
  – Linear
  – Depressed
  – Open
  – Impaled Object
• Basal Skull (floor)
  – Spaces weaken structure
  – Relatively easier to fracture

Lateral skull x-ray of a patient who presented with a severe intracranial injury produced by a golf club
Floor of Skull (notice ridges)

Contusions of the Frontal & Anterior Temporal Lobes Common

These structures are kind of in the same position as the headlights and bumpers of your car, so are prone to getting “smashed” or injured as they rub against the bottom of the skull.

If bruising allows blood to get into CSF, meningeal irritation & communicating hydrocephalus may develop (due to clogged arachnoid villi).

Coup-Contrecoup Injuries

The coup injury is caused when the head is stopped suddenly and the brain rushes forward. It not only gets injured by hitting in the side of the skull, but is also damned as it rubs against all the inner ridges.

The contrecoup injury is caused when the brain bounces off the primary surface and impacts against the opposing side of the skull. Again, additional injury occurs as the brain again rubs against all the inner ridges.

Damage in CHIs

- at point of impact ("coup")
- opposite point of impact ("contrecoup")
- where brain rubs against skull or presses against tough dural partitions
- where tissue is stretched, twisted or sheared - rapid deceleration causes diffuse axonal injury & petechia (pinpoint hemorrhages)
- where tissue is compressed by intracranial pressure (blood, swelling) or fracture or suffers from inadequate blood supply
**Diffuse Axonal Injury**

Causes immediate coma, risk of extreme brain swelling, Mortality of 30-40%

**Petechial Hemorrhages**

Possible downward cascade of events after a TBI

**Glasgow Coma Scale**

<table>
<thead>
<tr>
<th>Test</th>
<th>Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye opening</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>Eye opening</td>
<td>To pain</td>
<td>2</td>
</tr>
<tr>
<td>Eye opening</td>
<td>To verbal stimulus</td>
<td>3</td>
</tr>
<tr>
<td>Eye opening</td>
<td>Spontaneously</td>
<td>4</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>No response</td>
<td>1</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Inappropriate words</td>
<td>2</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Inappropriate words</td>
<td>3</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Disoriented</td>
<td>4</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Comatose</td>
<td>5</td>
</tr>
<tr>
<td>Motor response</td>
<td>No response</td>
<td>1</td>
</tr>
<tr>
<td>Motor response</td>
<td>Extension abnormal (decorticate)</td>
<td>2</td>
</tr>
<tr>
<td>Motor response</td>
<td>Extension normal (decorticate)</td>
<td>3</td>
</tr>
<tr>
<td>Motor response</td>
<td>Extension normal (decisive)</td>
<td>4</td>
</tr>
<tr>
<td>Motor response</td>
<td>Observe</td>
<td>5</td>
</tr>
<tr>
<td>Total score</td>
<td></td>
<td>3-15</td>
</tr>
</tbody>
</table>

Total scores can be between 3-15;
3-7 “Severe” head injury – comatose, can’t follow commands
8-12 “Moderate” – usually stuporous or sleepy, confused but can follow commands if aroused
13-15 “Mild” – may be lethargic and disoriented

**Head Injury Related Bleeding & Swelling Can Cause Secondary Injury**

- **Epidural/extradural hematoma** - most often after a blow to side of head damages middle meningeal artery, causing relatively rapid bleeding.
- May have lucid interval after initial signs of concussion but then rapid decline (within hrs) – develop headache, drowsiness, hemiparesis, 1 pupil may become fixed & dilated.
- Emergency surgery (craniotomy) to relieve growing pressure before brain herniates- high mortality if not treated.
- Initially TBIs are dynamic – can change in severity over hours or days because of these secondary changes. 20% of contusions can become hematomas

**Epidural Hematoma**

Convex, lens – shaped hematoma as blood depresses dura & brain

Craniotomy to remove clot outside of dura
Craniotomy

Increased Intracranial Pressure (ICP)
- No extra room in skull for extra blood or CSF or swelling
- ICP presses on brain causing ischemia (shortage of oxygen), symptoms, damage, and possible herniation
- Signs: Changes in consciousness, personality, breathing, motor function. Also headache, possible vomiting or seizures
- 2 indicators from the eyes:
  - Absence of normal “PERL” (Pupils Equal & Reactive to Light)- instead 1 or both may be “fixed and dilated” due to pressure on the nerves
  - Papilledema – bulging of the optic disk

Papilledema

Head Injury Related Bleeding (continued)
- Subdural hematoma - often due to front/back blow damaging veins, causing slower bleed over several hrs/days/ekas (S for Subdural and Slower). Crescent shaped on CT scan.
- Evacuation of subdural hematoma video
- Chronic subdural hematomas may be seen in elderly on anticoagulants even without much of a head injury; may also be seen in cases of child abuse
- Intracerebral hematoma - bruising of brain can cause bleeding inside brain (most often frontal or temporal)

Subdural Hematoma

Craniotomy to Remove Hematoma Under Dura
Craniotomy can’t reverse swelling however.
• Unrelieved intracranial pressure may cause herniation of the brain
• What is a hernia?
• Answer: Tissue is displaced from its usual "compartment" to another location

Brain Herniation Due to Pressure

• "Midline shift" past falx cerebri
• Medial temporal lobe past tentorium, causing pressure on midbrain
• Cerebellum/medulla thru foramen magnum, causing pressure on medulla
• Herniation can quickly cause coma and death
Looking Into Half of Skull

Floor of skull may fracture in the anterior fossa above nose or in the middle fossa near auditory canal.

Basal or Basilar Skull Fracture

- Sometimes visible surface of skull may be intact but injury causes hairline fractures of the bottom of the skull.
- May tear meninges or may injure the bones of the facial sinuses or auditory canal.
- Signs:
  - Raccoon’s eyes 2–3 days later
  - Battle’s sign behind ear
  - Blood behind eardrum
  - CSF leaks from ear or nose

Otorrhea, and Rhinorrhea

- Blood or CSF fluid due to skull fracture.

Postconcussive Syndrome

- Even a mild head injury or whiplash can be followed by days to weeks of:
  - Continued headache
  - Blurred vision
  - Dizziness or unsteadiness
  - Impaired concentration, thinking, memory
  - Emotional lability or irritability
  - Fatigue
  - Depression; anxiety
  - Noise sensitivity

More Serious Head Injury Sequelae (Aftereffects)

- Post-traumatic amnesia & cognitive difficulties (PTA) of varying degrees of severity
- Personality changes; psychological problems
- These 2 can result in changes in social, vocational and daily functioning
- Focal losses (e.g. motor) related to specific area damaged
- Meningitis if head was opened
- Post-traumatic epilepsy from scarring of brain
- Coma

Post-Traumatic Epilepsy

- Occurs in 60% with depressed fracture, 10-40% with hematomas
- Begins within 6 months in 25%, but may not occur for a few years
Coma & Related States

- Coma – total unconsciousness (eyes closed, can’t be aroused, no response to pain)
- Persistent vegetative state – eye opening and periodic wakefulness, eye movements, grimaces, grasping/groping, withdrawal from pain, but no real conscious awareness
- Minimally conscious state
- Locked-in syndrome – consciousness but almost complete paralysis due to brainstem damage

Prevention

- wear seatbelts; use infant seats
- avoid motorcycles; wear helmets
- don’t drink excessively (& don’t drive)
- beware of hazardous falls; use ladders appropriately
- beware of assault situations; projectiles