

### 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)

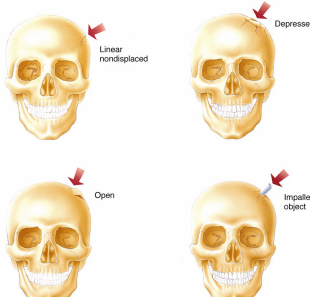
- About 300,000 sports-related head injuries/yr in US (9% serious)
- Sports involved (from more to less frequent)
  - Equestrian
  - Boxing
  - Football, soccer, rugby
  - Bicycling
  - Martial arts; auto racing
  - Hockey

### 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)

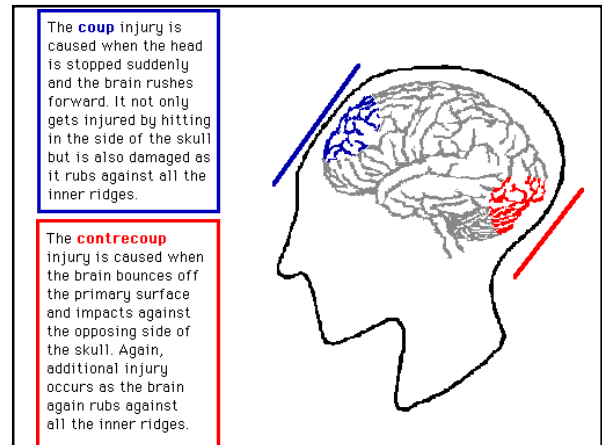
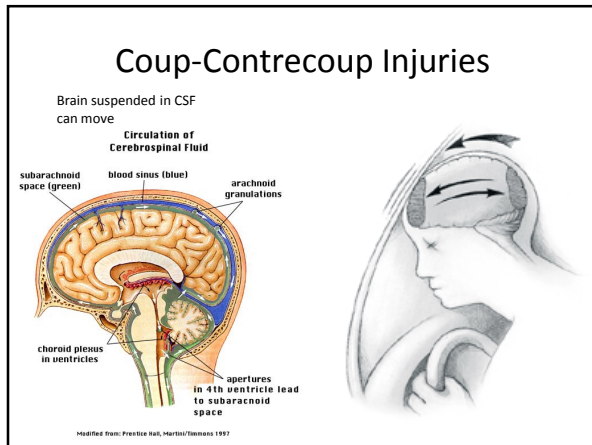
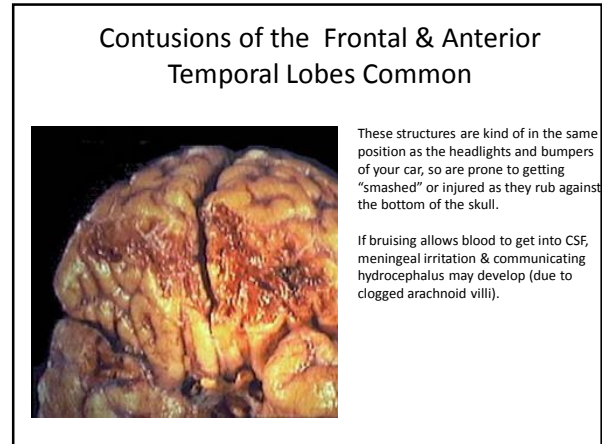
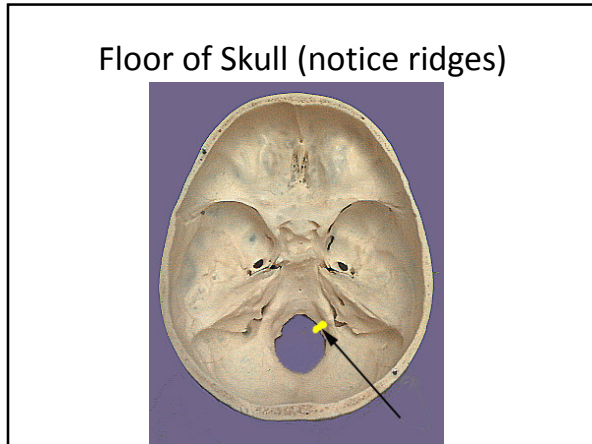
### Cranial Injury

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

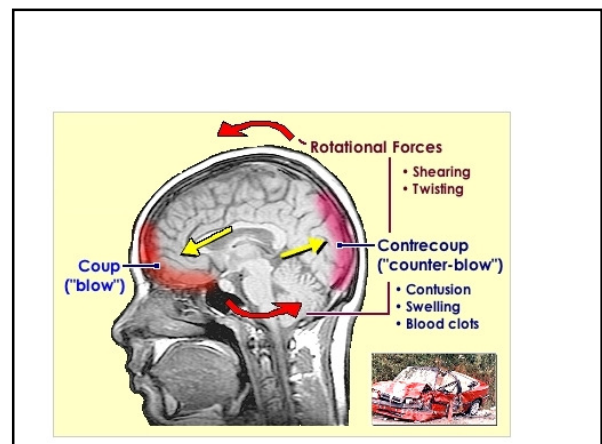


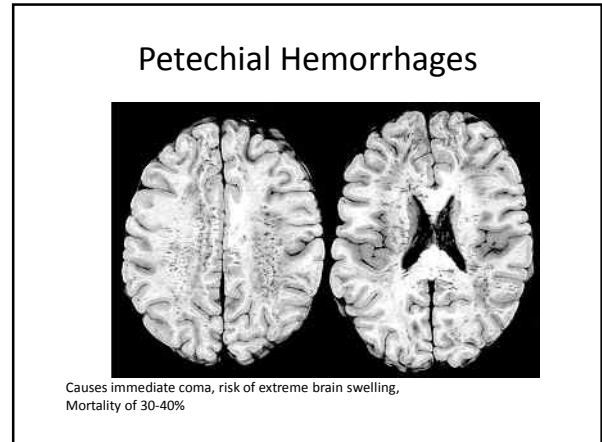
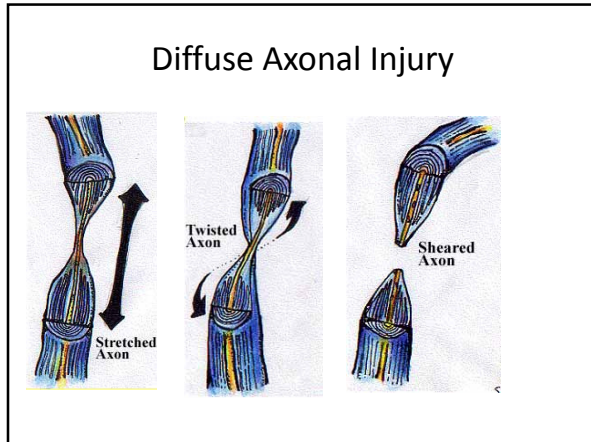
Lateral skull x-ray of a patient who presented with a severe intracranial injury produced by a golf club





- ### 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





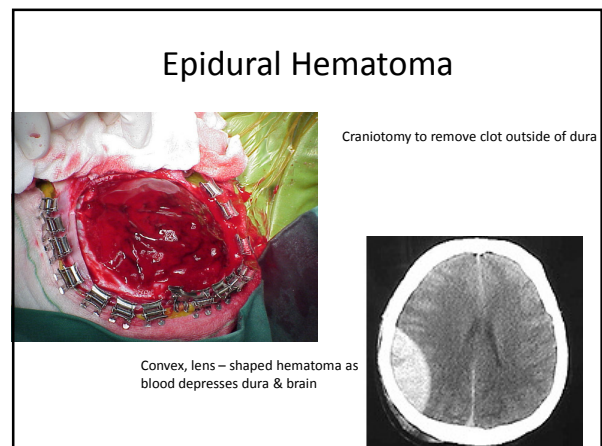
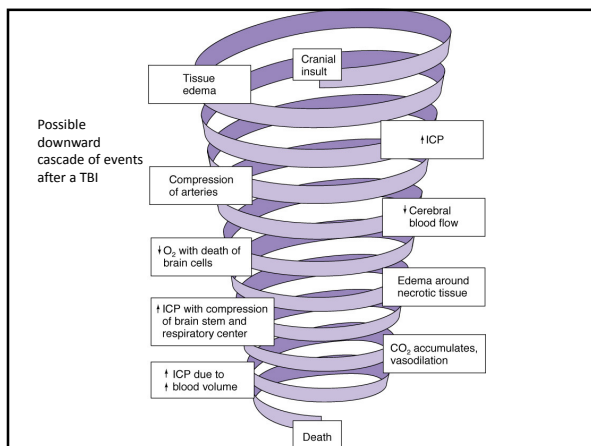
### Glasgow Coma Scale

Test	Response	Score
Eye opening	Never	1
	To pain	2
	To verbal stimuli	3
Best verbal response	Spontaneously	4
	No response	1
	Incomprehensible words	2
Best motor response	Inappropriate words	3
	Disoriented and converses	4
	Oriented and converses	5
	No response	1
	Extension abnormal (decorticate rigidity)	2
	Flexion abnormal (decorticate rigidity)	3
	Flexion withdrawal	4
	Localizes pain	5
	Obeys commands	6
<i>Total score</i>		3-15

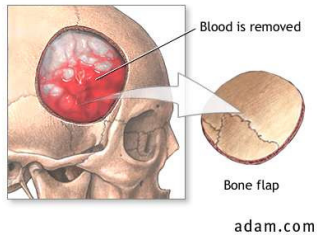
Total scores can be between 3-15;  
3-7 "Severe" head injury – comatose, can't follow commands  
8-12 "Moderate" – usually stuporous or sleepy, confused but can follow commands if aroused  
13-15 "Mild" – may be lethargic and disoriented

When used initially, the scale provides an estimate of severity of brain injury. Coma scores of 3 to 5 indicate potentially fatal damage, especially if accompanied by fixed pupils or absent oculo-vestibular responses. Admission scores of  $\geq 8$  correlate with likelihood of good recovery.

- ### 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



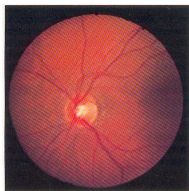
### Craniotomy



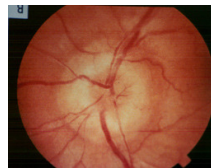
### Increased Intracranial Pressure (ICP)

- 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



Normal retina with distinct Optic disk

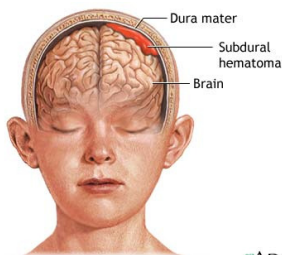


Disk swollen & bulging, borders indistinct

### Head Injury Related Bleeding (continued)

- Subdural hematoma - often due to front/back blow damaging veins, causing slower bleed over several hrs/days/wks (S for Subdural and Slower). Crescent shaped on CT scan.
- Evacuation of [subdural hematoma](#) video
- <http://pedscm.wustl.edu/All-Net/english/neurpage/trauma/head-8.htm>
- 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



More irregular shape as blood presses on thin inner membranes & brain

ADAM

### Craniotomy to Remove Hematoma Under Dura

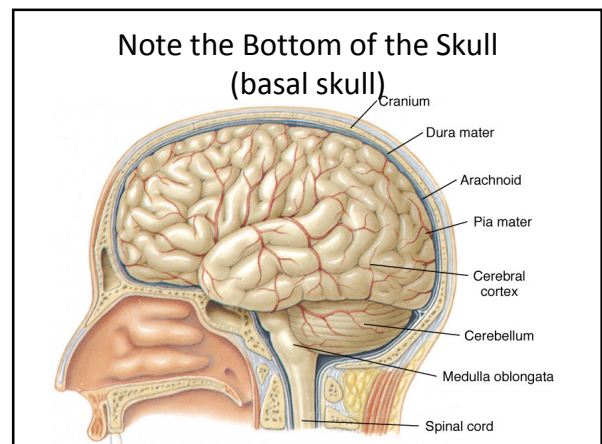
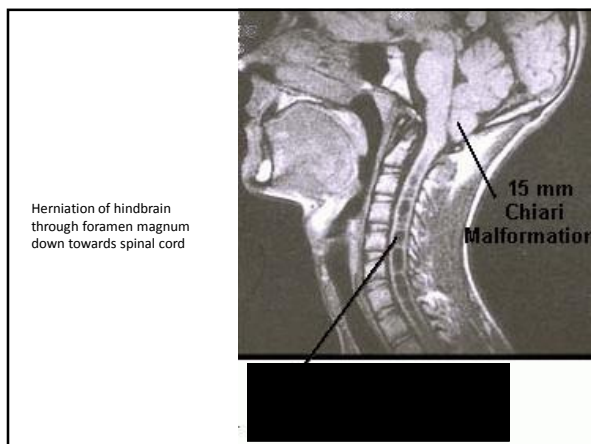
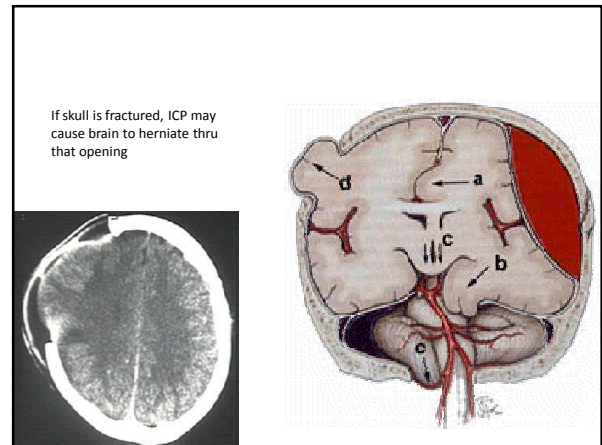
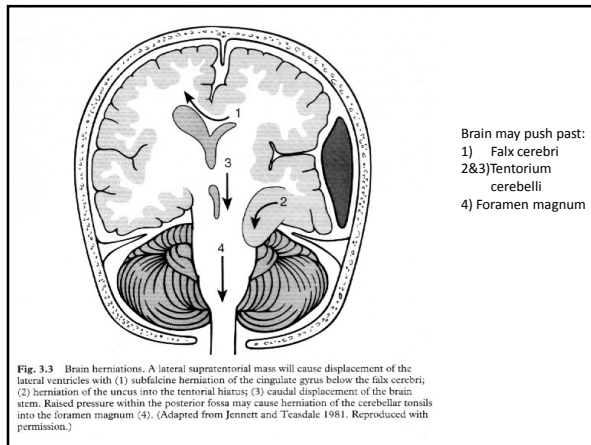
Craniotomy can't reverse swelling however.



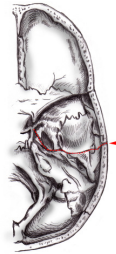
- Unrelieved intracranial pressure may cause herniation of the brain
- What is a hernia?
- Answer: Tissue is displaced from its usual "compartment" to another location

### 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



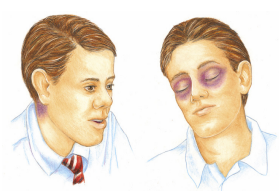


### Looking Into Half of Skull



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

Retroauricular ecchymosis (Battle's sign)

Bilateral periorbital ecchymosis (raccoon eyes)

"Raccoon Eyes"

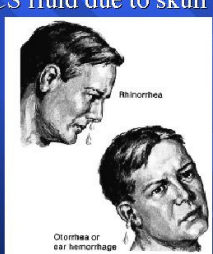

Basal skull fracture

Fracture near aud. canal

With orbital fractures

### Otorrhea, and Rhinorrhea

- Blood or CS fluid due to skull fracture

Rhinorrhea

Otorrhea or ear hemorrhage

Bloody fluid on gauze tends to show "halo sign" (lighter outside ring) from CSF

### 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