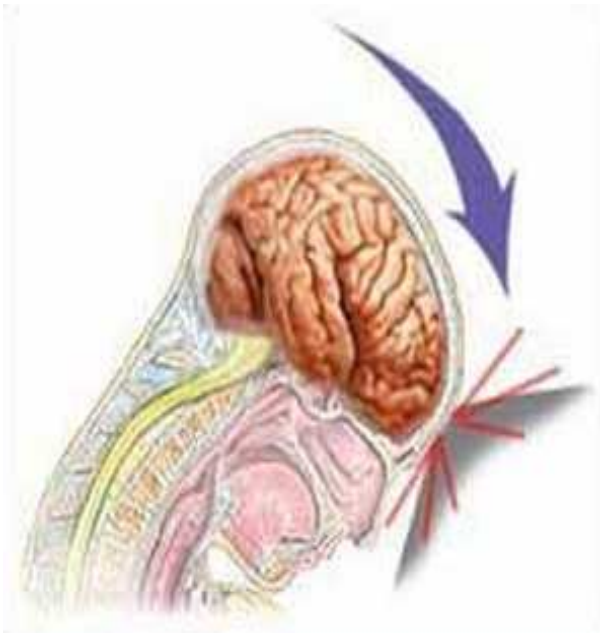


Concussion



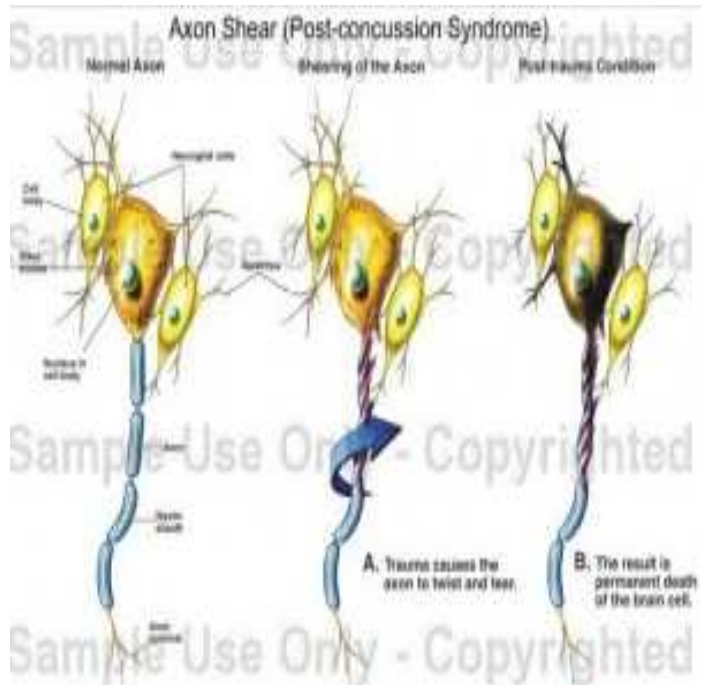
Definition

- A form of traumatic brain injury
- Alteration in cerebral function caused by a direct or rotational force transmitted to head resulting in combination of acute signs or symptoms
- Delayed signs and symptoms may include sleep irregularities, fatigue, personality changes, inability to perform usual daily activities, depression, or lethargy
- Although many concussions are mild, the range of injury is wide



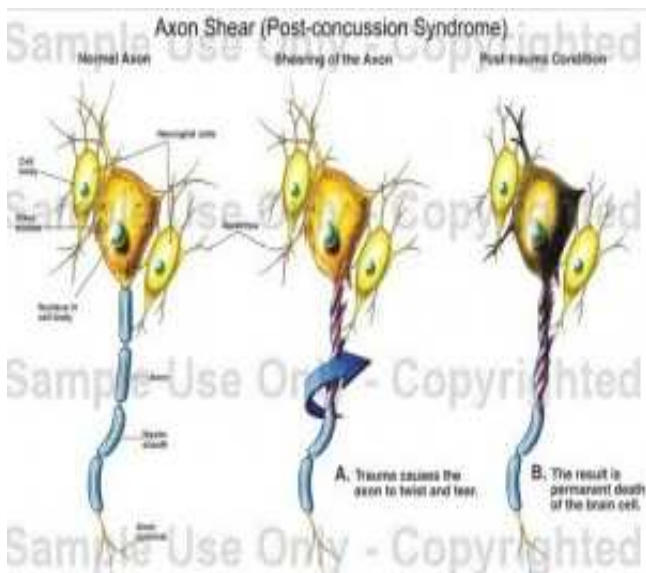
Diffuse axonal injury

- Diffuse axonal injury is the result of traumatic shearing forces that occur during rapid acceleration or deceleration as may occur in auto accidents, falls, and assaults
- Usually results from twisting or rotational forces, angular momentum, rather than forward and back impacts, linear momentum
- Car accidents are the most frequent causes of DAI, with sports accidents and child abuse also common causes



Diffuse axonal injury

- Diffuse axonal injury refers to extensive lesions in white matter tracts
- One of the major causes of unconsciousness and persistent vegetative state after head trauma
- Though seldom leading to death, with severe DAI the outcome is frequently coma with over 90% of severely afflicted patients never regaining consciousness
- Those that do wake up often remain significantly impaired



Context

- In United States, over 300,000 sports-related concussions occur annually
- Likelihood of suffering a concussion while playing a contact sport estimated to be as high as 19% per year of play
- More than 62,000 concussions are sustained each year in high-school contact sports
- Among college football players,
 - 34% have had 1 concussion
 - 20% have had multiple concussions



Signs and Symptoms

- Brief loss of consciousness
- Lightheadedness
- Vertigo
- Cognitive and memory dysfunction
- Tinnitus
- Blurred vision
- Difficulty concentrating
- Amnesia
- Headache
- Nausea and vomiting
- Photophobia
- Balance disturbance



What Athletes May Display

- Befuddled facial expression
- Slow to answer questions or follow instructions
- Easily distracted and unable to follow through with normal activities
- Walking in the wrong direction, unaware of time, date and place
- Disjointed or incomprehensible
- Stumbling, inability to tandem walk
- Distraught, crying for no apparent reason
- Repeatedly asking a question previously answered
- Inability to memorize or recall 3 of 3 objects in five minutes



Context

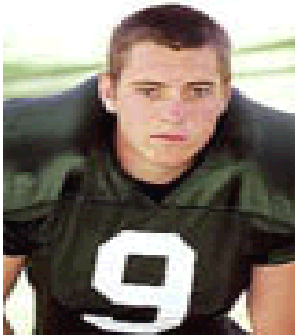
- Concussion has captured many news headlines as several professional football and hockey players have retired because of the effects of concussions
- Depending on the nature of the sport and the type (for example, rotation) and degree of contact expected, these injuries are many times viewed as just “part of the game”
- While many of these injuries are minor, some can be quite serious, with long-term consequences



Second impact syndrome

- In 1973, Schneider described deaths of two athletes after suffering relatively minor head injury during recovery from a previous concussion
- In 1984, Saunders and Harbaugh reported similar death in a 19-year-old college football player and coined the term "second-impact syndrome" (SIS)
- Since then, at least 26 deaths have been attributed to SIS, 20 of them occurring in past 10 years

[Foundation Formed To Educate On Dangers Of SIS](#)
By Brooke C. deLench



On September 28, 2001, seventeen-year-old Matthew Colby died after sustaining multiple head trauma sustained in a high school football game in California. In the wake of his tragic death, his uncle, Deron

Colby, has started a non-profit foundation in his name. Its mission: to educate the youth sport community on the dangers of concussions, especially when an athlete is allowed to return to play too soon.

[Read Full Story >>](#)

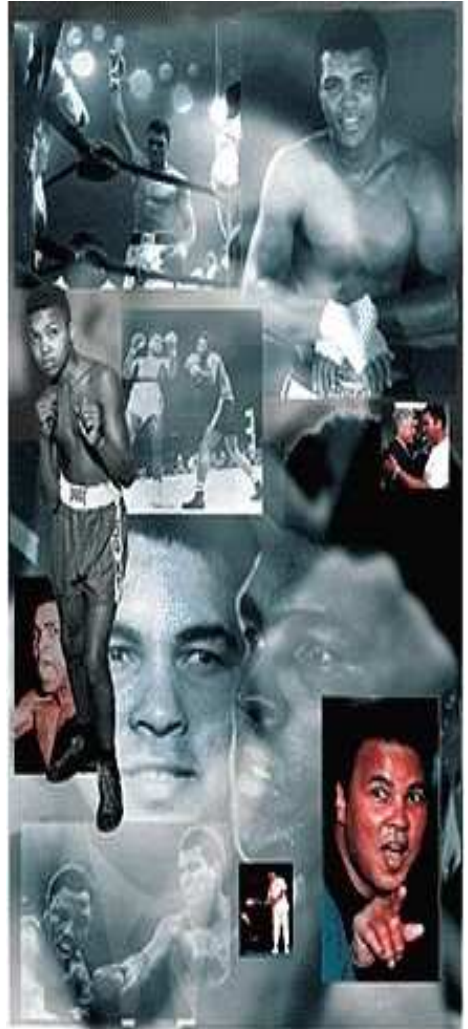
Chronic traumatic encephalopathy

- In 1928, H. S. Martland documented a neurological syndrome that was prevalent among boxers
- The term "punch drunk" was used by boxing managers and fans to describe the imbalance and "slight flopping of one foot or leg in walking" of boxers
- Some boxers also display other neuropsychological symptoms such as short-memory, short attention span, slow muscular movement, and difficulty in processing information
(Mendez 1995)



Chronic traumatic encephalopathy

- The symptoms are so similar to that of alcohol intoxication that a referee during Martland's time dismissed a fight due to his suspicion that one of the boxers was drunk
- Martland observed that the symptoms were not progressive
- However, a minority of boxers further developed speech difficulty, muscular movements like involuntary nodding of the head and hand tremors, and leg dragging (Martland 1928)
- In severe cases, symptoms of memory loss, shuffling gait, dizziness and mental deterioration were observed, similar to that of Parkinson's Disease



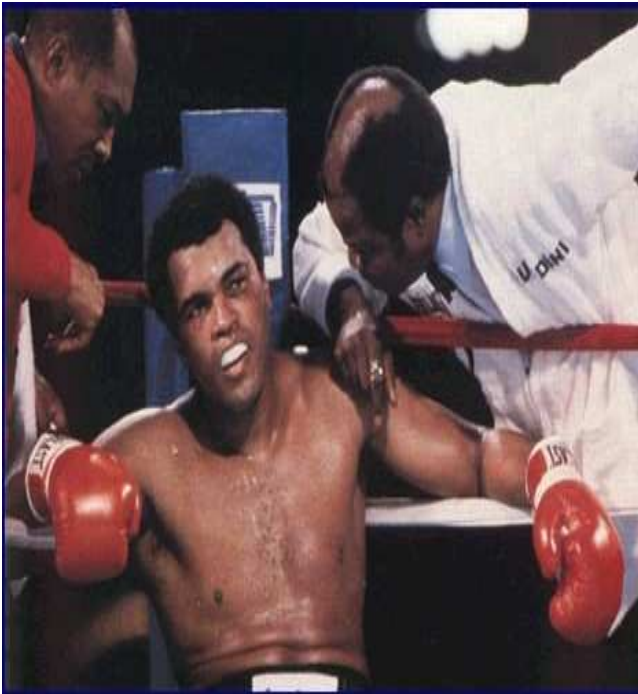
Chronic traumatic encephalopathy

- These symptoms were later collectively called chronic traumatic encephalopathy (CTE) and the progressive state, dementia pugilistica
- “Fly like a butterfly, sting like a bee”



Chronic traumatic encephalopathy

- Fast footwork, hand speed, repeated jabbing
- Rope-A-Dope
 - George Foreman - 1974
 - Defensive position, absorb blows, tire opponent



Chronic traumatic encephalopathy

- Most striking of symptoms is the disordered movement resembling that of Parkinson's Disease
- Cerebellum and Substantia Nigra suffer brunt of injury in chronic traumatic encephalopathy
- Glial fibrosis and the loss of Purkinje cells in the undersurface of the cerebellum are evident
- In the Substantia Nigra, the lack of large pigmented neurons is obvious



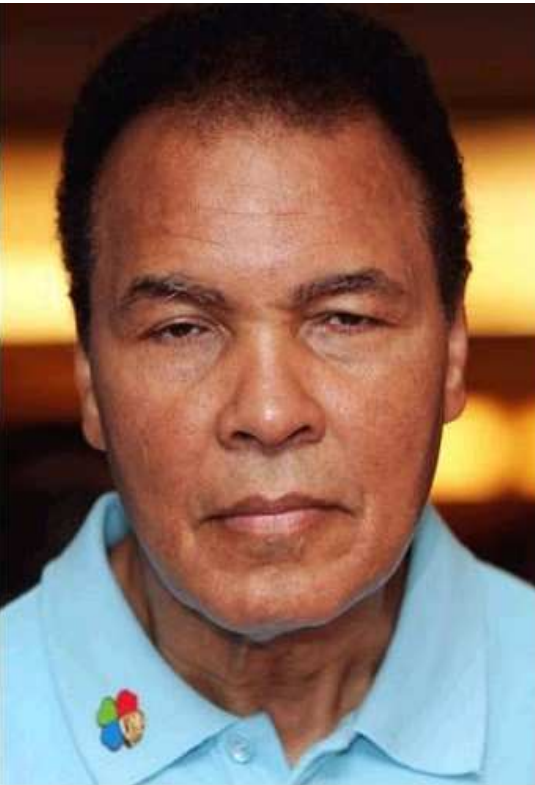
Chronic traumatic encephalopathy

- There are pathological similarities between Alzheimer's Disease and dementia pugilistica
- In both, there is an abnormal increase in the formation of neurofibrillary tangles, as well as "similar immunochemical characteristics, diffuse (- amyloid plaques and reduced cholinergic activity in the basal forebrain"
- A gene, APO E4, which encodes apolipoprotein E, has been identified with the induction of late-onset familial AD and the sporadic AD
- APO E2, on the other hand, is credited with reducing the risk of developing AD



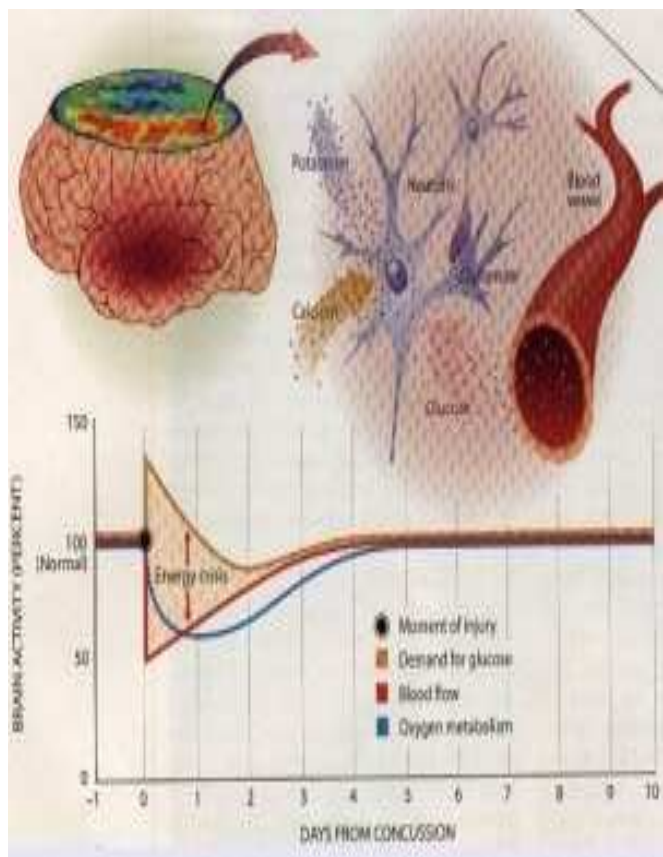
Chronic traumatic encephalopathy

- High-exposure boxers, more than twenty bouts, whose genotype contains a homozygous pair of alleles for APO E4 are more susceptible to neurological damage than those who are heterozygous or have no APO E4 allele at all
- Furthermore, boxers with the APO E2 allele are at lower risks for CTBI, consistent with the previous theory that APO E2 protects the brain against neurodegenerative disorders
- The findings are still preliminary



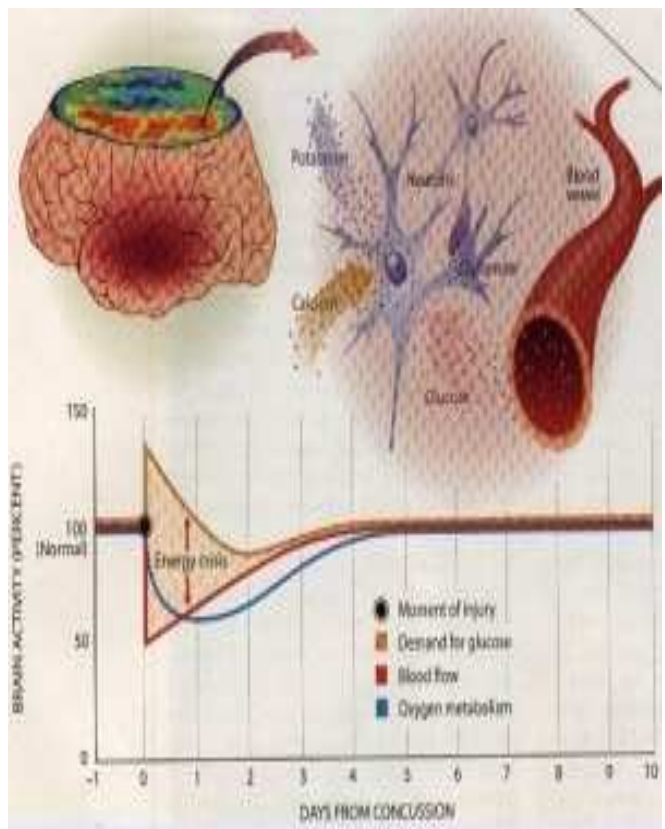
Pathobiology

- Decreased cerebral blood flow occurs with post-traumatic dysautoregulation
- May not be seen until 2-3 days after injury
- Often persists for more than a week
- Metabolic dysregulation, until fully resolved, may make the brain more vulnerable to a second injury
- Hypotheses based primarily on metabolic and physiologic information obtained from animal experiments or studies of severe TBI in humans



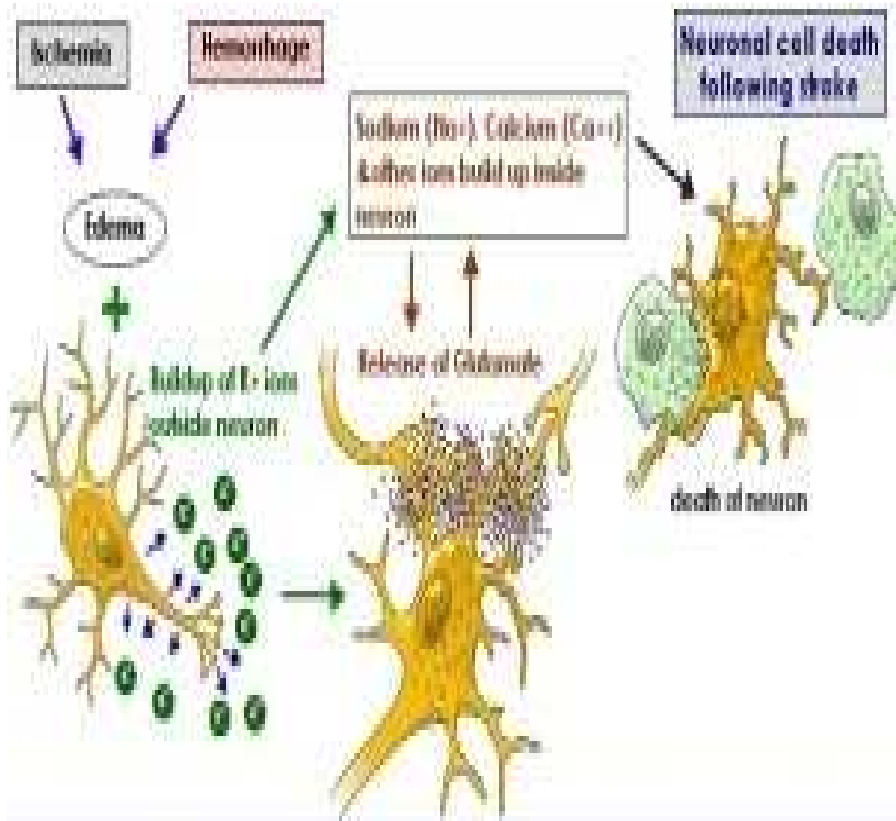
Pathobiology

- During minutes to days after concussion, brain cells - not irreversibly destroyed - exist in a vulnerable state
- Consequently, extreme vulnerability to even minor changes in cerebral blood flow and/or increases in intracranial pressure and apnea
- Experimental animal models have indicated that up to three days after concussion, a reduction in cerebral blood flow, normally well tolerated, produces extensive neuronal cell loss



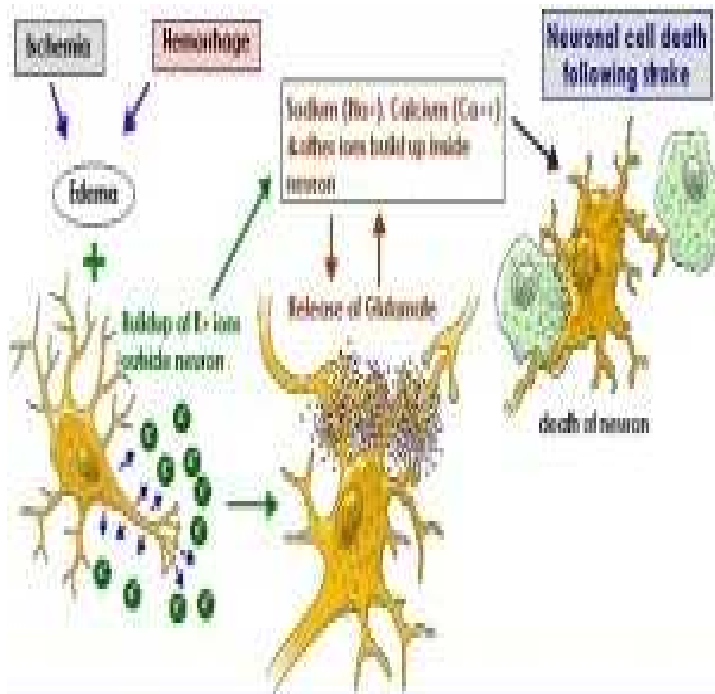
Pathobiology

- Enhanced vulnerability is characterized by both increase in demand for glucose and inexplicable reduction in cerebral blood flow
- The result is an inability of the neurovascular system to respond to increasing demands for energy to re-establish its normal chemical and ionic environments
- These altered environments can kill brain cells



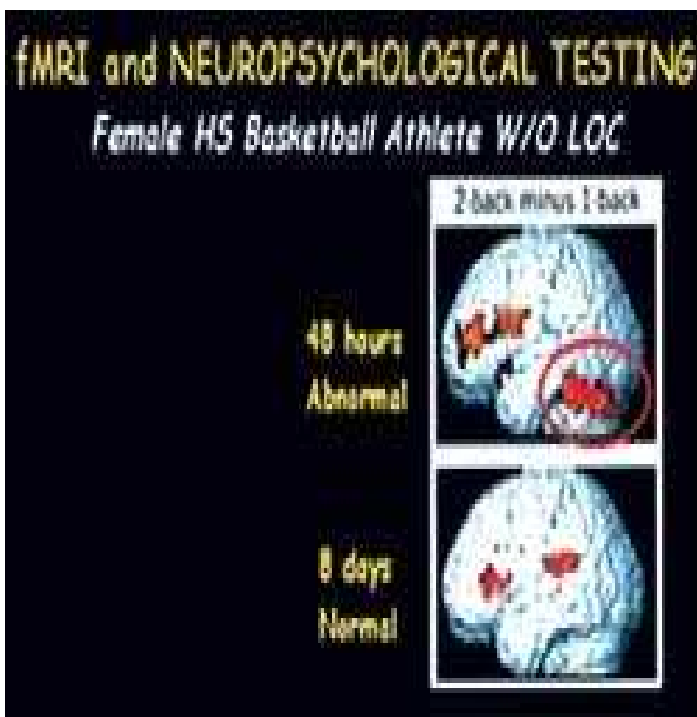
Pathobiology

- Injury-induced increase in demand for glucose is primarily response of cells activating sodium-potassium pumps
- Energy demand occurs immediately. Injured brain cells are exposed to massive ionic flux, including increased levels of extra-cellular K^+
- K^+ elevation is linked to stimulation of excitatory amino acid receptors since it can be drastically attenuated by blocking glutamatergic receptors before injury
- This extra-cellular K^+ increase activates ATP-dependent sodium-potassium pumps, resulting in metabolic stress to already damaged neural tissue



Pathobiology

- Many believe that signs and symptoms are related to metabolic dysfunction in the inferior parietal, prefrontal, and cingulate cortex
- Decreased cerebral blood flow, hyperglycolysis, glutamate-induced excitotoxicity, and abnormal cellular ionic fluxes occurring after TBI have been implicated
- Recent studies have suggested delayed metabolic dysautoregulation is caused by excitatory amino acid-induced ionic shifts with increased Na/K ATPase activation and resultant hyperglycolysis



Grading

- At least 14 different concussion scales published since 1973 with widely differing criteria for grading severity and resuming athletic activity
- Subtle post-concussive symptoms are often missed
- No agreement on definition
- Attempts to objectify diagnosis of concussion or post-concussive syndrome using multiple concussion scales, CT, MRI, and EEG have been unsuccessful

Return to Play

AAN Guidelines

1st Concussion

Grade 1

- Remove from contest and evaluate.
- May return to play if asymptomatic within 15 minutes.

Grade 2

- Remove from game and evaluate.
- May not return to practice or play until symptom free for one week.

Grade 3

- Remove from game and transport to hospital.
- Perform neurological exam and observe overnight.
- May return when symptom free for one week with history of brief unconsciousness.
- May return when symptom free for two weeks with history of prolonged unconsciousness.

Grade I

- Transient confusion (inattention, inability to maintain a coherent stream of thought and carry out goal-directed movements)
- No loss of consciousness
- Concussion symptoms or mental status abnormalities on examination resolve in less than 15 minutes



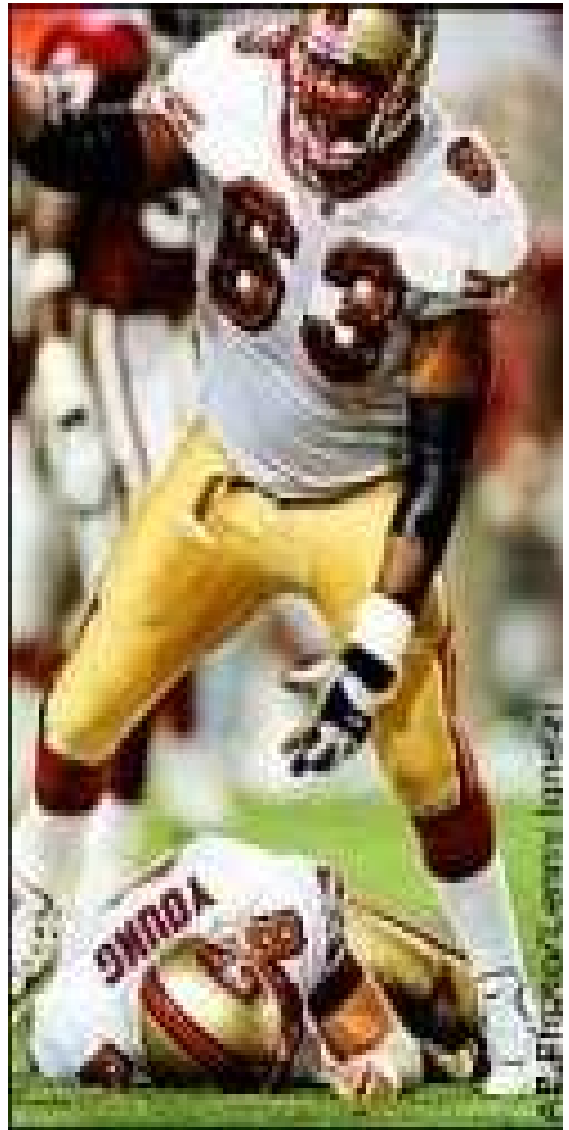
Grade II

- Transient confusion
- No loss of consciousness
- Concussion symptoms or mental status abnormalities on examination (including amnesia) persist more than 15 minutes



Grade III

- Any loss of consciousness
- Brief (seconds)
- Prolonged (minutes)



“Scales be abandoned in favor of combined measures of recovery to determine injury severity and/or prognosis and individually guide return to play decisions”

•Simple Concussion

an injury that progressively resolves without complication over 7-10 days

•Complex Concussion

persistent symptoms (including persistent symptom recurrence with exertion), specific sequelae (eg, concussive convulsions, prolonged loss of consciousness (>1 minute) or prolonged cognitive impairment following the injury

SUMMARY AND AGREEMENT STATEMENT INTERNATIONAL CONFERENCE ON CONCUSSION IN SPORT



15 April 2005

Following the Second International Symposium on Concussion in Sport in Prague in 2004, olympic.org has published on its website the summary and agreement statement relating to this conference.



[Read the document](#)

@IOPP/AFP/GARCIA **Latest research on head injury**

Looking back, the aim of the Symposium was to consider the latest research on head injuries with an emphasis first on rehabilitation, recovery and return to play, and secondly on guidelines to establish an effective concussion management programme. The scientific committee, composed of scientists and medical experts, including IOC Medical Director Patrick Schamasch, reviewed the progress made since the first symposium held in November 2001 in Vienna, Austria.

250,000 injuries in football

Concussion is the most common head injury that occurs when participating in sport, with more than 250,000 injuries reported annually by football players alone. Athletes most at risk from sports-related concussion participate in football, boxing, hockey, equestrian events and skiing.

Sideline evaluation

- Mental Status Examination
 - Orientation
 - Time, place, person and circumstances of injury
- Concentration
 - Repeat digits backwards
 - Months of year backwards
- Memory
 - Names of teams in prior contest
 - Recall of three words and objects at 0 and 5 minutes
 - Recent newsworthy events
 - Details of play (plays, moves, strategies)



Sideline evaluation

- Neurological Tests
- Strength
- Coordination and agility
- Sensation
- Exertional Provocative Tests
- 40-yard sprint
- 5 pushups
- 5 situps
- 5 kneebends



Differential diagnosis

Extra- or epidural hemorrhage

- usually an injury to ascending branch of mid-meningeal artery
- classical lucid interval, less than four hours, then signs of rapid space-occupying lesion

Second impact syndrome

- cerebral edema due to closed head injury during period of vulnerability
- controversial - ? less than 20 years old

Post-traumatic migraine (headache)

Subdural hematoma



The Best Approach To Concussion Management

Home	IMPACT Data	Other Presentations	IMPACT Team
Not Features	Go To News	Consultation	
Background	Publications	Current Tools	IMPACT Software

Who We Are IMPACT team members have dedicated the past 15 years to the scientific study of sports-related concussions and the clinical application of this knowledge throughout professional and amateur sports. IMPACT team members are widely acknowledged as world leaders in the field of concussion management and are committed to ongoing development of increasingly advanced concussion management tools.

What We Do IMPACT is a sophisticated, research-based software tool developed to help sports-medicine clinicians evaluate concussions following concussion. The IMPACT program evaluates and discriminates multiple aspects of neurocognitive functioning including memory, time processing speed, reaction time and post-concussive symptoms. In addition, the IMPACT program provides a user-friendly injury documentation system that facilitates the tracking of the injury from the field through the recovery process.

Enter the For Clients Only Website



Assessment

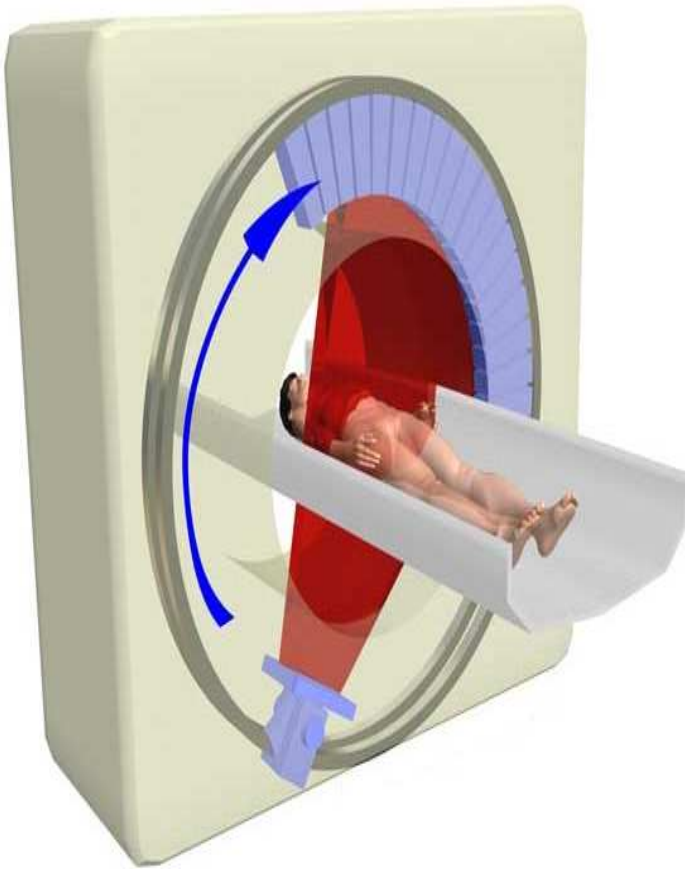
Questions to Ask Yourself

- Is this concussion?
- What is the time interval?
 - First four hours?
 - Four to 24 hours?
 - Greater than 24 hours?
- Is the concern focal neurological abnormalities?
- Is the concern neuropsych/neurocognitive?



Investigation

- Concern about bleeding or space-occupying lesion?
 - Repeated exam and CT of head
- Concern about neuropsych or neurocognitive function?
 - (?)MRI
 - Neuropsych assessment



American College of Radiology Advisory Panel (Adapted)

CT advantages include:

- Sensitivity for demonstration of mass effect, ventricular size and configuration, bone injuries, and acute hemorrhage
- Widespread availability, rapidity of scanning, and compatibility with other medical/life support devices

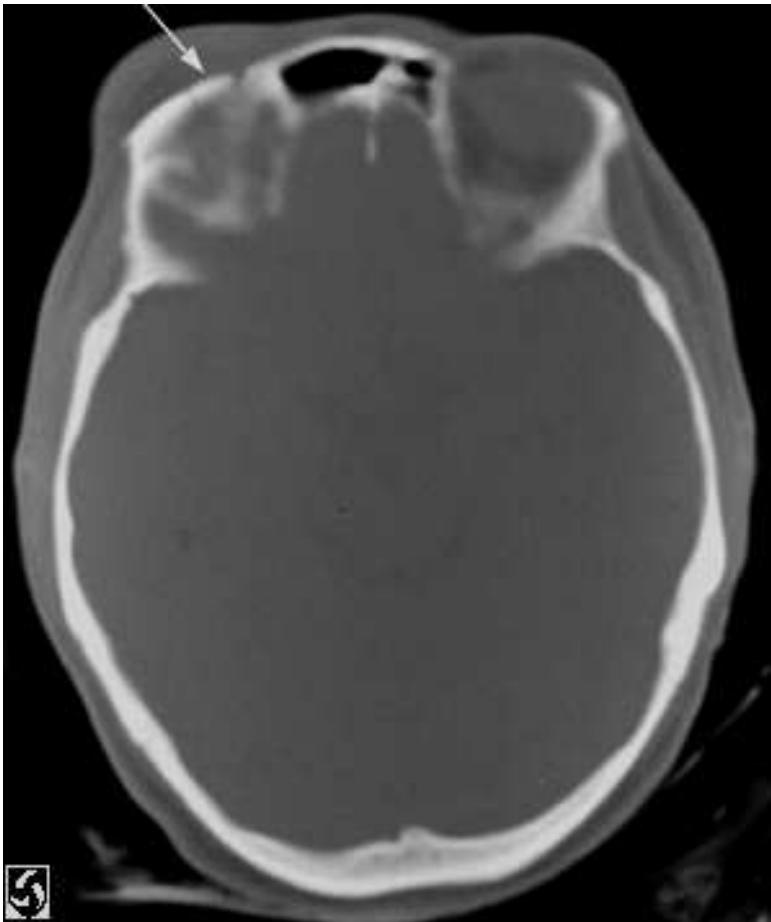


Limitations

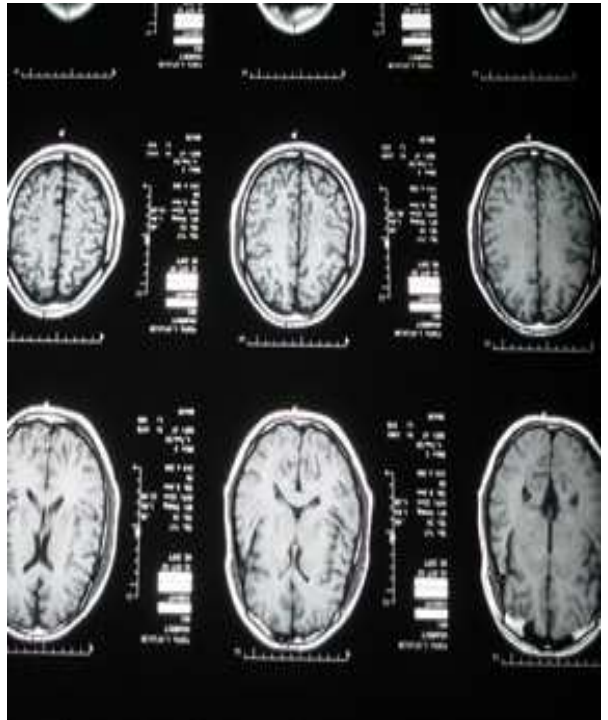
- Difficulty with detection of:
 - Small, predominantly nonhemorrhagic lesions such as nonhemorrhagic contusion
 - Diffuse axonal injuries (DAI) resulting in small focal lesions throughout cerebral hemispheres, corpus callosum, and upper brainstem and cerebellum
- Relative insensitivity for detection of increased intracranial pressure/cerebral edema and early demonstration of hypoxic-ischemic encephalopathy (HIE)



Now general consensus that patients identified as moderate-risk or high-risk for intracranial injury should undergo early post-injury non-contrast CT for evidence of intra-cerebral hematoma, midline shift, or increased intracranial pressure.



- Some authors now advocate MR scanning instead of CT for
 - study of neurologically stable moderate to severe closed head-injured patients;
 - CT is reserved for imaging of neurologically unstable or minor/mild head injuries.
- Although management of surgical injuries is not likely to be altered by the substitution of MR for CT, the possibility exists that the superior depiction of non-surgical lesions with MR will affect optimization of medical management and predict success of neurological recovery



Neurocognitive Testing

- Evaluation and tracking of:
 - Memory
 - Brain processing speed
 - Reaction time
 - Post-concussive symptoms



Neuropsychological Testing

- Advice about intellectual disability
- Educational re-structuring
- Reversibility/irreversibility



Return to play

Caveat

Assumes no symptoms, normal neurological assessment at rest and with exercise

Grade 1

- 15 minutes or less
- If multiple, one week

Grade 2

- One week
- If multiple, two weeks

Grade 3

- Brief (seconds) - one week
- Prolonged (minutes) two weeks
- Multiple - one month or longer

