

Concussion Definition and Pathophysiology

The Evolving Definition of Concussion

CDC Physicians Toolkit; Collins, Gioia et al 2006

Regarding Cerebral Concussion.....

A concussion (or mild traumatic brain injury) is a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head.

Disturbance of brain function is related to neurometabolic dysfunction, rather than structural brain injury, and is typically associated with normal structural imaging findings (CT Scan, MRI). Concussion may or may not involve a loss of consciousness. Concussion results in a constellation of physical, cognitive, emotional, and sleep-related symptoms. Recovery is a sequential process and symptoms may last from several minutes to days, weeks, months, or even longer in some cases.”

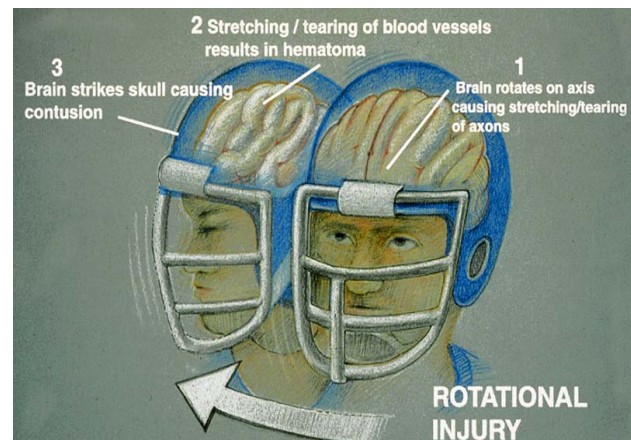
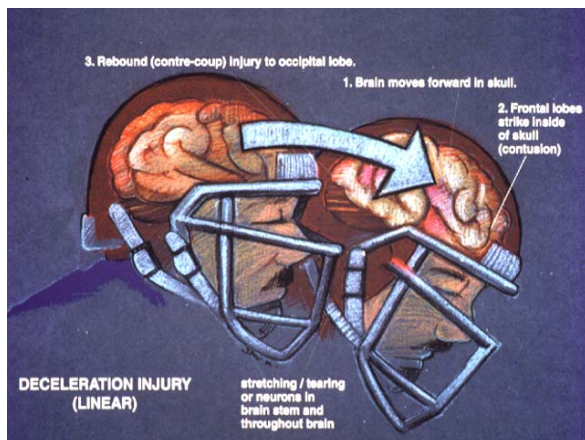
- Following a concussion, there are metabolic chemical changes that take place in the brain.
- Brain injury can occur even if there is **NO** loss of consciousness.
- More than 90% of concussions **DO NOT** involve loss of consciousness.
- Memories of events **BEFORE** and **AFTER** the concussion are **MORE** accurate assessments of **SEVERITY** than loss of consciousness.

Pathophysiology of Concussions –

Dr. Micky Collins, Director UPMC Sports Medicine Concussion Program

Neurometabolic Cascade of Concussion

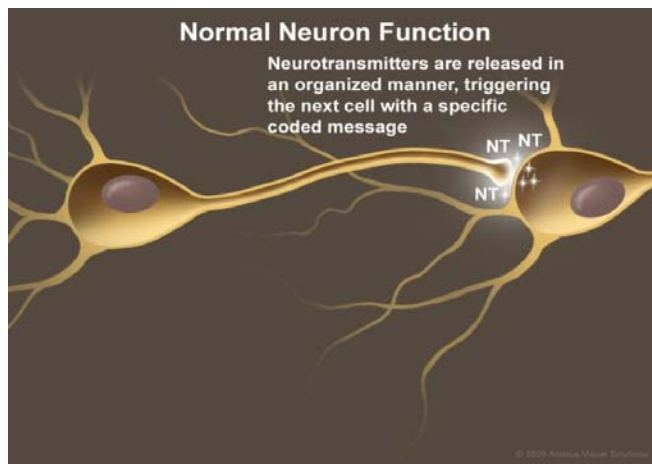
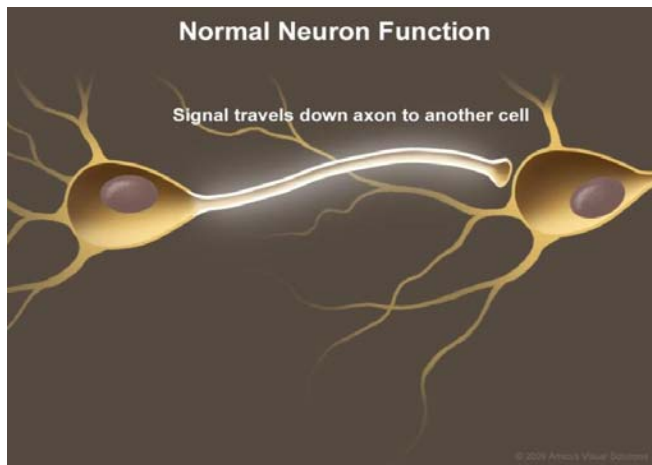
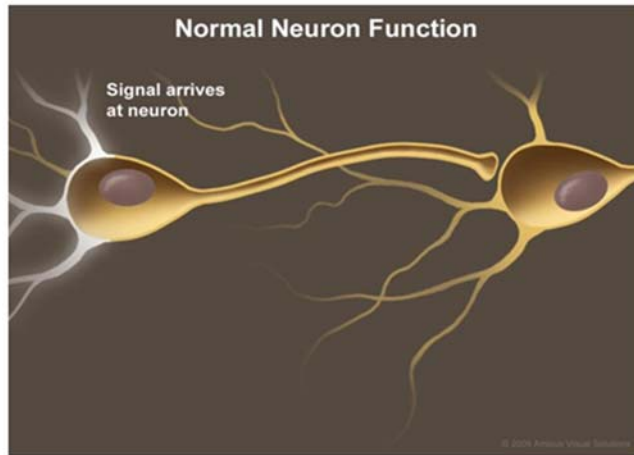
During activities a concussion can occur with any type of external force to the head. These events can cause the brain to accelerate and decelerate with translational, rotational and/or angular forces. Brain injuries can result on the side of the force, cu, or the opposite side of the force, contra cu.



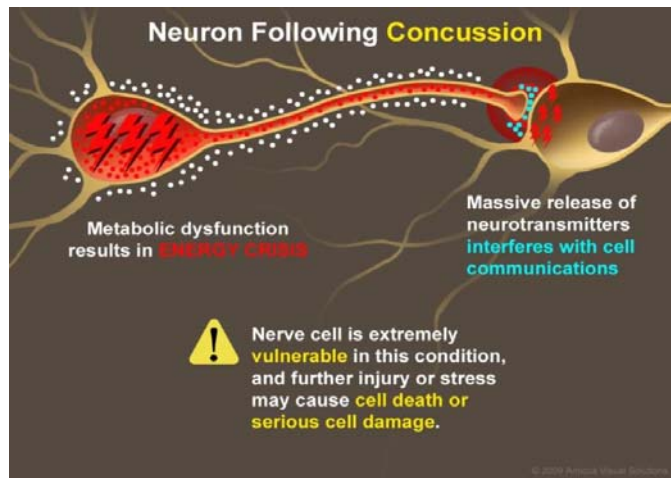
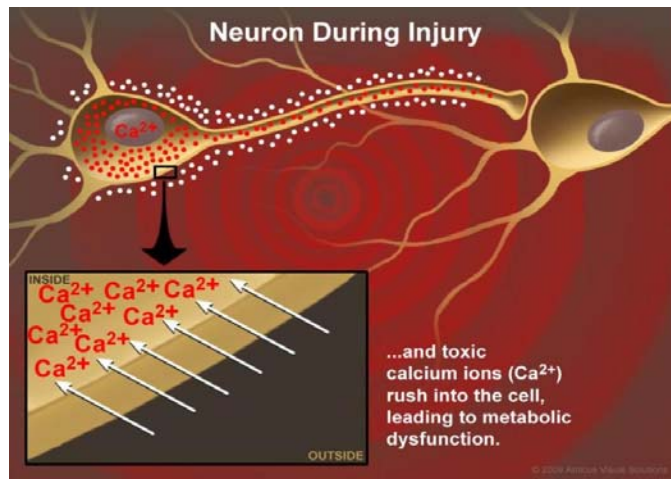
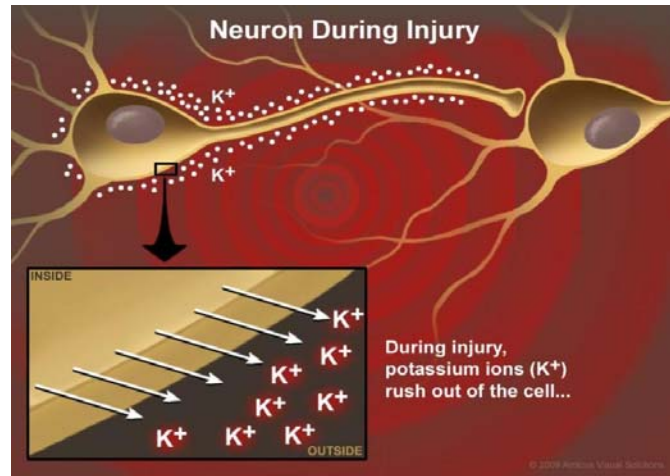
So what exactly do these forces do to the brain?

Researchers believe it leads to a wave of energy that passes through the brain tissue triggering neuronal dysfunction. This involves a complex cascade of ionic, metabolic, and physiologic, sometimes called the neurometabolic cascade of concussion. This cascade, as well as microscopic axonal dysfunction, cause concussion symptoms. In most cases this process will generally correct itself and the majority of patients will fully recover. However, while the brain is still recovering, the reduction in cerebral blood flow may result in cell dysfunction that increases the vulnerability of the cell to second insult.

In **Normal Neuron Function** the components of the neuron which include: the dendrites, nerve cell body, axon, and synapse, are involved in a process in which a signal arrives at the neuron and the signal travels down the axon to another cell, (at synapse) and neurotransmitters are released in an organized manner, triggering the next cell with a specific coded message. See below:



However, the **Neuron During Injury** releases its K^+ (Potassium), which rushes out of the cell body and toxic Ca^{2+} (Calcium) ions rush into the cell, leading to metabolic dysfunction. See below:







Youth at Increased Risk

Athletes of all ages, participating in sports, are at risk for concussion; 65% of concussions occur in children between 5 and 18 years of age.

- These children are at a greater risk for traumatic brain injury as the young brain of a pediatric athlete is still developing and tissue is not as able to recover as quickly as an adult brain.
- They are more susceptible to neurochemical and metabolic changes, their axons are not yet well insulated or myelinated, their cervical and shoulder musculature is less developed resulting in a decreased ability to absorb mechanical energy throughout their bodies, and they are less likely to use proper techniques to reduce risk.
- All concussions are serious.
- The majority will recover within the first 3-4 weeks.
- In some cases symptoms persist for much longer and 5-10% last a lifetime.
- Until recovered, children should receive accommodations in all settings to promote cognitive rest.

Signs and Symptoms CDC 2012

|  THINKING/ REMEMBERING |  PHYSICAL |  EMOTIONAL/ MOOD |  SLEEP DISTURBANCE |
|--|--|---|--|
| <ul style="list-style-type: none"> • Difficulty thinking clearly • Feeling slowed down • Difficulty concentrating • Difficulty remembering new information | <ul style="list-style-type: none"> • Headache • Nausea or vomiting (early on) • Balance problems • Dizziness • Fuzzy or blurry vision • Feeling tired, having no energy • Sensitivity to noise or light | <ul style="list-style-type: none"> • Irritability • Sadness • More emotional • Nervousness or anxiety | <ul style="list-style-type: none"> • Sleeping more than usual • Sleeping less than usual • Trouble falling asleep |

**Most Common Reported Symptoms
Athletes with Concussion 1-7 days following concussion**

| | SYMPTOM | PERCENT |
|------|--------------------------|----------------|
| # 1 | Headache | 75% |
| # 2 | Difficulty Concentrating | 57 % |
| # 3 | Fatigue | 52 % |
| # 4 | Drowsiness | 51 % |
| # 5 | Dizziness | 49 % |
| # 6 | Foggy | 47 % |
| # 7 | Feeling Slowed Down | 46 % |
| # 8 | Light Sensitivity | 45 % |
| # 9 | Balance Problems | 39 % |
| # 10 | Difficulty with Memory | 38 % |

Kontos, Elbin, French, Collins Data Under Review N=1,438