Background: Concussion

Concussion is damage to brain caused by mechanical force. Such blows to the head are common in certain contact sports, such as football and boxing. In football, hard tackles or blocks can cause concussion. The same thing can happen even in a sport like soccer, when hitting the ball with the head. Concussion can also occur in explosions, even when nothing penetrates the head.

A concussion breaks the contact points between nerve cells (neurons). Force to the head causes the brain to move away from the force (Remember Newton's law? ... every force produces and equal and opposite reaction). The problem here is that the brain has nowhere to go. The brain slams into the skull that contains it, and this transfers the force into brain tissue. The tissue will tear in proportion to the magnitude of the force.

Why does it matter if neurons don't stick together well? There are at least three reasons. Neurons signal each other by special contact points called synapses between adjacent cell membranes. Concussion-caused separation of synapses would disrupt signaling between neurons. Other cells in the brain also matter. Did you know that most of the cells in the brain are not nerve cells? The vast majority of brain cells support neurons. We call these support cells "glia," a word that means glue. One type of glial cell sticks to blood vessels, forming a so-called "blood-brain barrier," which helps keep toxins in the blood stream from entering the brain. Another glial type wraps itself around the membranes of neurons, forming an electrical insulating coating, which speeds the movement of nerve impulses and reduces noisy electrical interference from adjacent neurons.

Behavior is impaired when neurons cannot communicate normally with each other. Maybe you have seen coaches do a sideline examination of a football player after a big hit. They look for symptoms like a dazed expression, confusion, slow response to questions, headache, or disrupted coordination. Concussion damage may be lasting and accumulate with repeated blows.

Researchers are trying to figure out what happens in neurons during concussion. If scientists understood the mechanisms, they might be able to develop drug treatments to reduce or compensate for the damage. An obvious place to start is with the proteins in cell membranes that link adjacent cells together. We should expect that the force of concussion would disrupt the linking of the proteins that form the bridge between cells Concussion could tear these "sticky" proteins and separate cells from each other. Below is our version of the original that was approved by real peer reviewers (fellow scientists) before it was accepted for publication.

Original report: Hemphill MA, Dabiri BE, Gabriele S, Kerscher L, Franck C, Goss JA, et al. (2011) A Possible Role for Integrin Signaling in Diffuse Axonal Injury. PLoS ONE 6(7): e22899. **https://doi.org/10.1371/journal.pone.0022899**. Adapting author: W. R. Klemm

Vocabulary

Intracellular: inside the cell
Extracellular: outside the cell
Synapses: junction points between neurons. These are patches of neuron membrane though which currents are most able to flow.