



SPORT-SPECIFIC CONDITIONING CONSULTANTS

'Sport-Specific Conditioning is our Focus, Performance is our Goal'

- PERFORMANCE NUTRITION - ATHLETIC TRAINING - ATHLETE DEVELOPMENT- PERFORMANCE PSYCHOLOGY - MANAGEMENT & CONSULTING -

Performance Training Systems Inc. Sport Concussion Management

Resources for the Athlete, Coach, Athlete Support Personnel and Parents

Concussion Pathophysiology

Recent research reveals that in both animals and humans, brain trauma, can alter the brain's physiology for hours to weeks, setting into motion a variety of pathological events. Though these events are thought to interfere with neuronal and brain function, the metabolic processes that follow concussion are reversed in a large majority of affected brain cells; however a few cells may die after the injury.

Included in the cascade of events unleashed in the brain by concussion is impaired neurotransmission, loss of regulation of ions, deregulation of energy use and cellular metabolism, and a reduction in cerebral blood flow. Excitatory neurotransmitters, chemicals such as glutamate that serve to stimulate nerve cells, are released in excessive amounts as the result of the injury. The resulting cellular excitation causes neurons to fire excessively. This creates an imbalance of ions such as potassium and calcium across the cell membranes of neurons. Since neuron firing involves a net influx of positively charged ions into the cell, the ionic imbalance causes cells to have a more positive membrane potential (i.e. it leads to neuronal depolarization). This depolarization in turn causes ion pumps that serve to restore resting potential within cells to work more than they normally would. This increased need for energy leads cells to require greater-than-usual amounts of glucose, which is made into ATP. The brain may stay in this state of hypermetabolism for days or weeks. At the same time, cerebral blood flow is relatively reduced for unknown reasons, though the reduction in blood flow is not as severe as it is in ischemia. Thus cells get less glucose than they normally do, which causes an "energy crisis". Concurrently with these processes, the activity of mitochondria may be reduced, which causes cells to rely on anaerobic metabolism to produce energy, which increases levels of the by-product lactate.

For a period of minutes to days after a concussion, the brain is especially vulnerable to changes in intracranial pressure, blood flow, and anoxia. According to studies performed on animals (which are not always applicable to humans), large numbers of neurons can die during this period in response to slight, normally innocuous changes in blood flow.

Concussion involves diffuse (as opposed to focal) brain injury, meaning that the dysfunction occurs over a widespread area of the brain rather than in a particular spot. Concussion is thought to be a milder type of diffuse axonal injury because axons may be injured to a minor extent due to stretching. Animal studies in which primates were concussed have revealed damage to brain tissues such as small petechial haemorrhages and axonal injury. Axonal damage has been found in the brains of concussion sufferers who died from other causes, but inadequate blood flow to the brain due to other injuries may have contributed to the damage. Findings from a study at Boston University's School of Medicine's Centre for the Study of Traumatic Encephalopathy that analyzed the brains of dead NFL athletes who received concussions suggest

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there is lasting damage to the brain after experiencing one. This damage was a form of brain disease called Chronic Traumatic Encephalopathy and is associated with behavioural, physical and cognitive problems.

The debate over whether concussion is a functional or structural phenomenon is ongoing. Structural damage has been found in the mildly traumatically injured brains of animals, but it is not clear whether these changes would be applicable to humans. Such changes in brain structure could be responsible for certain symptoms such as visual disturbances, but other sets of symptoms, especially those of a psychological nature, are more likely to be caused by reversible pathophysiological changes in cellular function that occur after concussion, such as alterations in neurons' biochemistry. These reversible changes could also explain why dysfunction is frequently temporary.

Performance Training Systems is an athletic conditioning consulting firm based out of Brampton, ON, Canada. We provide athlete development, exercise nutrition, performance psychology, athletic training, and management and consulting services to clients within the greater Toronto area and around the world. We are committed to ethical sport values based training, and promote sport as a vehicle for developing healthy bodies, healthy minds, and healthy communities.

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