

“Concussion”

- ▶ *What is concussion?*
- ▶ *How do you diagnose concussion?*
- ▶ *What are the complications of concussion?*
- ▶ *If a schoolboy is concussed at rugby, for how long should he avoid contact sport before resuming?*

Do you know the answers to these vexing questions? Anybody treating South African rugby players will be confronted by these questions at sometime. Rugby is not the only sport where head injuries occur so this is an area where all primary care health workers will have to offer input at some time in their careers.

The word concussion has its origin in the Latin verb *concutere* (“to shake violently”). The term Cerebral concussion and mild traumatic brain injury are used interchangeably.

The evaluation and treatment of athletes with cerebral concussions or mild traumatic brain injury (MTBI) are medically challenging and may have profound social and economic consequences for the athletes, as well as medical and legal implications for the treating physicians¹.

There is extensive literature concerning both the experimental and clinical aspects of cerebral concussion yet there is still controversy regarding the commonly accepted definitions, grading systems and guidelines as to management of this problem. This article attempts to summarise the information and provide some practical guidelines in dealing with this problem.

DEFINITION

Torg defined classic cerebral concussion as a “phenomenon of physiological neurological dysfunction with no anatomic disruption”²

In 1997 the Quality Standards Subcommittee of the American Academy of Neurology³ defined cerebral concussion as a traumatically induced alteration in mental status that may or may not involve a loss of consciousness. This definition emphasises the fact that cerebral concussions do, indeed, occur without loss of consciousness and it establishes that confusion and amnesia are major factors in decisions regarding whether to permit athletes to return to contact sports participation.

Concussion can be defined as a transient disturbance of neurological function induced by head trauma. **This may**

or may not involve a loss of consciousness but there is no anatomical disruption detectable.

INCIDENCE

This is difficult to quantify but general practitioners will see a number of cases each year. In 1997 the Centre for Disease Control and Prevention in Atlanta reported that an estimated 300,000 sports-related brain concussions occur each year in the United States⁴. The CDC report also detailed two new cases of second-impact syndrome. 20% of all American Football players have been concussed. It is estimated that $\frac{1}{3}$ of these are seen by a doctor.

Approximately 10% of schoolboy rugby players will receive a concussion.

So What? Does it matter?

The definition says that concussion is transient i.e. it passes and that there are no anatomical abnormalities that can be detected. Surely then there is no need to be excited about the condition.

Even if an athlete never returns to contact sports, a single concussion can be life threatening. A closed head injury may involve intracranial hemorrhage, considered the leading direct cause of death in contact sports⁵. No physician wants to send a brain-injured player back into a game, where he or she would be vulnerable to a second head injury. The biggest worry in returning an athlete to play is second-impact syndrome, a rapid, fatal brain swelling that may occur if a person suffers another head impact - even a minor one - before the symptoms of a previous concussion have fully cleared. Although it is rare, the deaths of several boxers, football players, and hockey players have been ascribed to second impact syndrome since it first was widely publicized

in 1984⁶. After recovery, the player's chance of suffering another concussion may be four times as high as that of a player who has never had a concussion⁷. Repeated concussions could cause cumulative, permanent neurological damage - like the "punch-drunk syndrome" seen in some boxers.

Some interesting facts about concussion:

- Compressive forces are well tolerated by the brain due to the presence of cerebrospinal fluid. Tensile and shearing forces are poorly tolerated and are more likely to cause injury.
- Even in minor head injury widespread neuropathological changes are sometimes observed. These changes may be the basis for cortical atrophy that occurs with repetitive injury i.e. the so-called "punch-drunk" syndrome seen in boxers.
- A concussed athlete, although conscious and without obvious focal neurological signs may have impaired higher cortical function e.g. impaired short-term memory.
- Loss of consciousness does not necessarily imply greater neural damage, greater morbidity, or a poorer ultimate outcome
- The most sensitive tests for significant effects after concussion are neuro-psychological tests.
- The neuropsychological effects of mild concussion were assessed in 60 university players over 4 follow up examinations. Deficits were still detectable at 3 months in a small number of concussed players despite subjective reports that they had fully recovered. Note this is mild concussion.⁸
- Neuropsychological advice is not to play for three months following concussion! Imagine handing out this advice to the local star in a first team rugby squad who has recently sustained a concussion!
- Neurological dysfunction in concussion is transient, but the athlete has sustained a significant impact to the brain.
- In virtually every significant diffuse brain injury there is a period of amnesia that surrounds the impact that caused it. Memories that are newly recorded are volatile.
- When someone sustains a significant blow to the head, the last memories prior to impact are lost. This is called **retrograde amnesia** i.e. backward loss of memory. The length of time of retrograde amnesia may span a significant time and may shrink with the passage of time. The memory gap that follows the injury, the **post-traumatic or anterograde amnesia**, is considered to be a more reliable indicator of the severity of the injury than retrograde amnesia.

■ SIGNS AND SYMPTOMS OF CONCUSSION ■

Following a cerebral concussion, a variety of neurological symptoms and signs may be experienced. Those related

primarily to the **brainstem, or dysfunction of its connections** are:

- Unconsciousness
- Tinnitus
- Light-headedness
- Unsteadiness
- Ataxia
- Headache
- Nausea
- Vomiting
- Inco-ordination

Other symptoms may relate to effects primarily upon the cerebral cortex **viz:**

Acute:

- Confusion
- Disorientation
- Anterograde and retrograde amnesia
- Decreased information processing
- Short-term memory impairment

Delayed in onset:

- depression
- fatigue
- sleep disturbance
- irritability
- feeling "foggy"

Confusion and amnesia are emphasized as the hallmarks of concussion. The confusional episode and amnesia may occur immediately after the blow to the head or several minutes later.

Testing the Concussed patient

Besides a good history and neurological examination are there special investigations we should be doing? CAT scans and MRI scans of the brain are done to rule out anatomical lesions. If they are present then the injury is no longer a concussion but the pathological entity so detected. Signs and symptoms relating to cortical dysfunction have been shown to be very sensitive to neuropsychological testing, especially when a baseline has been established.

■ NEUROPSYCHOLOGICAL TESTING OF ATHLETES ■

The effects of mild head injuries can be assessed using neuropsychological tests and that the majority of players typically return to baseline performance within 10 days after injury.⁹ These tests seem to provide a sensitive guide to ongoing and possible cumulative problems after mild traumatic brain injury e.g. a test known as the *digit symbol substitution test*, tests speed of information processing and is a sensitive marker of cognitive dysfunction in concussed athletes. Cognitive deficits can be detected by neuropsychological testing and research is being carried out to make this a practical possibility with computer based

tests instead of having a whole battery of neuro-psychologists to help.

Post concussive symptoms must also be evaluated viz:

- Somatic symptoms - headaches dizziness, balance problems or nausea
- Neuropsychiatric symptoms - anxiety, depression and irritability
- Cognitive complaints - impairment of attention, memory or processing speed.

This can be done by the use of scales that have been developed e.g. The Pittsburgh Steeler's Post Concussion Scale.¹

There are no tests of new learning or permanent memory, which a number of studies have found to be impaired after concussion and even after minor head injury¹⁰

THE METABOLIC BASIS OF CEREBRAL CONCUSSION

The loss of consciousness after head injuries, the development of secondary brain damage, and the enhanced vulnerability of the brain after an initial insult can be explained largely on the basis of characteristic ionic fluxes, acute metabolic changes, and cerebral blood flow alterations that occur immediately after cerebral concussions.

Minor head trauma may cause pathological alterations in potassium and calcium levels, can produce a physiological mismatch between oxygen/glucose demand and delivery, and can cause a loss of cerebral auto-regulation, all of which may lead to an increased vulnerability whereby a second trivial insult may predispose to ischaemia and cellular death.

Many studies (referenced in 1) have confirmed initial massive increases in the extracellular potassium concentrations after concussion, lasting between 3 and 5 minutes, in large brain regions. The excitatory amino acids, especially glutamate, seem to open ligand-gated channels, resulting in large ionic flux. When the extracellular potassium concentration increases beyond the normal upper limit of approximately 4 to 5 mmol/L, to levels of 20 to 50 mmol/L and greater, then inhibition of the action potential and loss of consciousness may occur.

In certain situations, it may require several seconds or longer for the potassium levels to accumulate above threshold levels, thus explaining the athletes who walk from the field and then collapse unconscious on the sidelines.

COMPLICATIONS OF CONCUSSION

SECOND-IMPACT SYNDROME

Saunders and Harbaugh⁶ coined the term SIS and emphasized the potential catastrophic outcomes that could

occur after seemingly minor concussions if a second impact occurred while the athlete was still exhibiting symptoms. Twenty-six deaths have been attributed to SIS since the original report by Saunders and Harbaugh, but the diagnosis remains controversial. In second-impact injuries, the athletes typically experience a post-concussion syndrome, which may include visual, motor, or sensory abnormalities and difficulty with cognitive processes. If the athletes return to competition before the resolution of these symptoms, another blow, although minor, may result in malignant cerebral oedema and even death, in rare instances. Nonetheless, it must be concluded that SIS is an infrequent finding, predominately involving young athletes, and only rarely is fatal. The real problem with concussion is the effects of "minor" brain assaults

Several "mild" head injuries give rise to as much injury as from a single more serious one.

The information processing ability is more severely affected and takes longer to recover in patients after the second or third concussive injuries than in patients with a single mild head injury.

The person "uses up the reserves" of neuronal function.

Impaired reaction time and delayed information processing associated with concussion may result in the athlete failing to cope with potential injurious situations and sustaining further cerebral or musculoskeletal injury.

The second impact to the head of an injured person is of major significance and can cause further injury out of proportion to the severity of the blow. Post-concussive symptoms may be prolonged.

The post-concussive syndrome is fatigue, difficulty in concentration, and headaches persisting for some time, often months after the original injury.

Multiple concussive episodes can result in chronic cortical dysfunction e.g. boxers.

MANAGEMENT OF THE CONCUSSED ATHLETE.

The most important task is to exclude a presence of serious head or spinal injury. If the patient is conscious the first step is to exclude the presence of a spinal injury.

The athlete should always be removed from the field of play if you think he is concussed, i.e.

- Any confusion, loss of consciousness or focal neurological deficit in a player should result in the player being withdrawn from the game.