

Sports-related concussion relevant to the South African football environment

The incidence of concussion is lower in football than in other contact sports such as rugby.

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Concussion is a trauma-induced change in mental state that may or may not involve loss of consciousness. The injury may manifest with any combination of physical, cognitive, emotional and sleep-related symptom clusters, including headache, dizziness, nausea, visual disturbances, amnesia, poor concentration, irritability, depressed affect, fatigue and drowsiness.

The last 8 years has seen a more collated approach to head injury management in sports persons than in the past. The watershed occurred in 2001 at the First International Conference on Concussion in Sport, held in Vienna. During this conference, a comprehensive systematic approach to concussion was formulated for application in sport, which included computer-based neuropsychological testing as an integral part of a comprehensive clinical concussion evaluation. Since then consolidation of the Vienna guidelines has taken place at the Second International Conference in Prague (2004), the National Athletic Trainers Association (USA, 2004), the American College of Sports Medicine (2005) and the Third International Conference in Zurich (2008) with published clinical management guidelines based on these consensus meetings. Significantly for football, this most recent collaborative meeting was co-sponsored and hosted by FIFA.

Incidence

Football has a lower incidence of concussion than other contact and collision sports such as rugby, American football and ice hockey, with figures varying from 0.18 to 0.6 incidents per 1 000 athletic exposures, as opposed to an incidence of 6 - 9 per 1 000 for rugby. Nevertheless, the injury remains a significant one in football, as evidenced by the injury to both of Chelsea's goalkeepers Petr Czek and Carlo Cudicini in a premier league game in October 2006, and then their captain John Terry who was accidentally kicked in the head later in the same season.

Pathophysiology

The precise pathophysiology of concussion is unknown. Research has shown that moderate to severe brain injury causes a complex cascade of neurochemical changes in the brain. The assumption is that similar changes occur in concussion. Immediately after biomechanical injury to the brain, abrupt, indiscriminant release of neurotransmitters and unchecked ionic fluxes occurs. The binding of excitatory transmitters, such as glutamate, to the N-methyl-D-aspartate (NMDA) receptor leads to further neuronal depolarisation with efflux of potassium and influx of calcium. These ionic shifts lead to acute and subacute changes in cellular physiology. Acutely,

in an effort to restore the neuronal membrane potential, the sodium-potassium (Na⁺-K⁺) pump works overtime. The Na⁺-K⁺ pump requires increasing amounts of adenosine triphosphate (ATP), triggering a dramatic jump in glucose metabolism. This 'hypermetabolism' occurs in the setting of diminished cerebral blood flow, and the disparity between glucose supply and demand triggers a cellular energy crisis. The resulting energy crisis or 'mismatch' may account for the symptoms and behavioural changes as well as being a likely mechanism for post-concussive vulnerability, making the brain less able to respond adequately to a second injury and potentially leading to longer-lasting deficits.

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Concussion grading

The historical grading of the severity of concussion is controversial. The concept of traditional mandatory exclusion periods based on the grading of concussive injuries is not helpful and is based on data from motor vehicle accidents. The lack of validity of grading systems in a sporting milieu has led to a move away from such dogmatic guidelines to a more individualised approach.

Chronological approach to the clinical management of the concussed footballer

On-field

The aim of immediate management is to stabilise the head-injured player. Basic aspects of first aid involving cervical spine protection followed by airway, breathing and circulation evaluation and management take priority. In more subtle cases, a validated brief on-field neuropsychological test can be administered in the form of Maddock's questions, suitably modified for rugby, to assess recent memory. These questions have been shown to be sensitive in discriminating between concussed and non-concussed players (Table I).

Table I. Modified Maddock's questions

- Which ground are we at?
- Which team are we playing today?
- Who is your opponent today?
- Which half is it?
- How far into the half is it?
- Which side scored last?
- Which team did we play last week?
- Did we win last week?

Fieldside

It should be emphasised that the concussed player must be assessed by a medical doctor as soon as possible following injury. The main aims of the fieldside assessment are to confirm the diagnosis of concussion, perform an initial (baseline) symptom analysis and to 'red flag' players requiring urgent referral to hospital (Table II). A practical tool for this assessment is the pocket Sports Concussion Assessment Tool or SCAT card (Fig. 1). This is a summary of symptoms to look out for and easy questions to ask in assessing the athlete on the field, formatted into a user-friendly card format. Following this, the team physician must decide if there is any indication to refer to hospital or whether the player may be adequately managed at home. Home supervision requires a responsible adult to be present, as well as a set of guidelines (Table III).

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Hospital referral and brain imaging

The results of standard brain imaging techniques are almost always normal in concussion. If the player has been unconscious for any period of time, has deteriorating drowsiness, recurrent vomiting, unusual or aggressive behaviour or focal neurological signs, it is recommended that he be referred to a tertiary care hospital for either a computed tomography (CT) or magnetic resonance image (MRI) scan to be performed. The primary intention of these investigations is the exclusion of intracranial bleeds and cerebral oedema, and they are almost always normal in cases of concussion. If there are no indications for these investigations and the concussed player's condition is improving over an initial 2-hour observation period he/she may

Table II. 'Red flags' – indications for urgent referral to hospital for special investigation and admission

Any player who has or develops the following:

- Fractured skull
- Penetrating skull trauma
- Deterioration in conscious state following injury
- Focal neurological signs
- Confusion or impairment of consciousness >30 minutes
- Loss of consciousness >5 minutes
- Persistent vomiting or increasing headache post injury
- Any convulsive movements
- More than one episode of concussive injury in a match or training session
- Where there is assessment difficulty (e.g.: an intoxicated patient)
- All children with head injuries
- High-risk patients (e.g. haemophilia, anticoagulant use)
- Inadequate post-injury supervision
- High-risk injury mechanism (e.g. high-velocity impact, missile injury)

Table III. Patient discharge information for 48 hours after injury

- A normal X-ray, CT or MRI scan does NOT exclude concussion
- You may be referred home after being assessed. In this case:
 - always make sure that you are in the presence of a responsible adult for 48 hours
 - record and monitor the symptoms of concussion including headache, nausea, dizziness, fatigue, sleep disturbances, memory lapses, mood swings, poor concentration or any other feeling that concerns you
 - complete rest and sleep will help recovery
- Do not:
 - drive a motor vehicle or motor cycle if symptomatic
 - consume alcohol
 - take excessive amounts of painkillers (follow doctor's orders)
 - place yourself in an environment of loud noise and excessive light
 - study
 - work at the computer
 - exercise until re-evaluation by a doctor
- Contact your nearest emergency department immediately if:
 - any of the symptoms deteriorate
 - the headache becomes severe or does not respond to mild analgesics (e.g. Panado)
 - you have a seizure (fit)
 - you experience excessive irritability
 - you experience visual disturbances
 - you experience balance problems
 - you or anyone else is concerned about your condition
- Decisions regarding returning to sport will be made taking into consideration your individual circumstances including medical history, previous head injuries and current symptoms
- You must receive clearance from a doctor before returning to sport

be discharged home in the care of a responsible adult who is in possession of a head injury advice form (Table III).

Follow-up consultation

Return-to-play decisions require serial medical evaluations and should not be made after the initial fieldside and/or

emergency room evaluations. This is one of the central tenets of modern concussion management protocols.

The evaluations should preferably be performed by a clinician (sports medicine physician, neurologist or neurosurgeon) with experience in concussion management and who is *au fait* with

Pocket SCAT2



Concussion should be suspected in the presence of **any one or more** of the following: symptoms (such as headache), or physical signs (such as unsteadiness), or impaired brain function (e.g. confusion) or abnormal behaviour.

1. Symptoms

Presence of any of the following signs & symptoms may suggest a concussion.

- Loss of consciousness
- Seizure or convulsion
- Amnesia
- Headache
- "Pressure in head"
- Neck Pain
- Nausea or vomiting
- Dizziness
- Blurred vision
- Balance problems
- Sensitivity to light
- Sensitivity to noise
- Feeling slowed down
- Feeling like "in a fog"
- "Don't feel right"
- Difficulty concentrating
- Difficulty remembering
- Fatigue or low energy
- Confusion
- Drowsiness
- More emotional
- Irritability
- Sadness
- Nervous or anxious

Fig. 1. Pocket SCAT card.

recommended guidelines. To facilitate this, Sports Concussion South Africa has introduced the concept of the Sports Concussion Centre, a multidisciplinary network of cross-referring medical professionals with skills in head injury management co-ordinated by the primary care sports medicine physician. The skills of neurologists, neurosurgeons, neuropsychologists, physiotherapists and exercise therapists/biokineticists may be employed for specific indications, for instance where neurological complications or associated injury are present, or return-to-play guidance is required. Co-ordination of an athlete's management by a psychologist alone or via Internet or telephonic consultation is deemed clinically inappropriate and medicolegally treacherous.

The aim of serial evaluations is to determine whether the player has fully recovered

from concussion and is able to return to play. If symptoms and signs are gross the period between re-assessments may be longer (about 1 week), while more frequent visits may be appropriate as resolution nears. In order to obtain as much clinical information as possible the following parameters should be more thoroughly assessed at follow-up consultations:

- History of the specific head injury
- History of previous concussions or associated injuries (neck, maxillo-facial)
- Symptoms at the time of injury
- Current symptoms
- Verbal and numeral competency
- Balance
- Cardiovascular status – blood pressure, pulse

- Neurological status
 - Cranial nerves
 - Motor function
 - Sensory function
 - Cerebellar function
- Associated injuries, especially involving the neck.

The Zurich guidelines included the useful Sports Concussion Assessment Tool 2 (SCAT 2) tool which is the standard international template for clinical assessment of concussed players and can be accessed at <http://www.mshsl.org/mshsl/news/ConcussionTool.pdf>

Neuropsychological testing

A neuropsychological test is designed to assess the ability of the brain to process information (cognitive function).

Examples of computerised test batteries include Automated Neuropsychological Assessment Metrics (ANAM), CogState Sport, Headminders and the Immediate Post-concussion Assessment and Cognitive Testing (ImpACT). The tests can be administered by team physicians and performed as part of a pre-season evaluation forming a baseline neuropsychological assessment. These pre-injury data ensure more reliable comparisons with post-concussion assessments, will aid in the detection of subtle cognitive impairment, eliminate the need to compare with 'normative data' and assist with accurate clinical decision-making.

It should be emphasised that the concussed player must be assessed by a medical doctor as soon as possible following injury.

A neuropsychologist, as part of the multidisciplinary sports concussion team, should be consulted if cognitive function is severe and prolonged, in cases of recurrent concussion over a short period, in players who appear to suffer concussion with relatively minor impacts, where neurological or psychological comorbidity exists (e.g. depression, attention deficit disorder, migraine sufferers) and in cases where a decision to stop a player partaking in contact or collision sport

is to be considered. In these cases the neuropsychologist will perform a more extensive battery of verbal, pencil-and-paper and computerised tests to establish the cognitive implications of the injury.

Return-to-play decisions require serial medical evaluations and should not be made after the initial fieldside and/or emergency room evaluations.

Return-to-play protocol

The final phase of a safe, structured and supervised concussion rehabilitation protocol involves the progressive exposure of the recovering athlete to increasing degrees of exercise intensity while symptoms are monitored. This process should be preceded by both clinical and cognitive recovery. In other words, the player should be asymptomatic, have a normal neurological examination and neuropsychological data (where utilised) that have returned to baseline or are comparable with age-appropriate norms. The process progresses through 5 phases from light exercise through to sport-specific training and the end-point, which is a return to match competition over at least 5 days. Education of especially minors as well as their parents and coaches is helpful as is a printed return-to-play protocol and medical certificate of clearance.

Pharmacological intervention

One of the frustrations of treating mild traumatic head injuries is the lack of direct positive influence that the clinician has on the outcome. Although much can be done that may aggravate the condition, such as exposing the patient to physical and cognitive stress, there is as yet no evidence-based pharmacological treatment that the physician can administer to the concussed patient that will influence the course of the condition. Hence the physician's role has been described as promoting 'masterly inactivity'.

Pharmaceutical agents with the potential for influencing the neurometabolic cascade postulated as being central to the pathophysiology include corticosteroids, calcium channel blockers, antioxidants and glutamate receptor antagonists. Potential non-pharmacological avenues

include hyperbaric oxygen therapy and hypothermia.

The other area of intervention involves the treatment of post-concussive symptoms. Headache may be treated with mild analgesics that do not influence the potential for bleeding (e.g. paracetamol NOT non-steroidal anti-inflammatory drugs), nausea with anti-emetics, prolonged dizziness with anti-vertigo agents, insomnia with hypnotics, affective disorders with SSRIs and cognitive or attention deficit with neurostimulants such as methylphenidate. Again these treatments are intuitive and empirical and there is no evidence that they influence the pathophysiology or outcome of concussion. Moreover, treatments to manage more prolonged post-concussive symptoms should be monitored by the broader team of clinicians including neurologists and neuropsychologists.

Football-specific concussion issues

Two further issues specifically pertaining to football warrant discussion. The first is the question of whether repetitive heading of the ball causes or predisposes to concussion. In summary, despite suggestions from one early (poorly designed) study that suggested a possible link between heading the ball and head injury, more recent studies using both neurochemical and neuropsychological analysis reveal that repeated heading of the ball is not associated with injury to the brain. The explanation is likely to be that heading is an anticipated, controlled activity for which the body is braced, the neck muscles contracted and the head stabilised, as opposed to head impact with the ground or opponents' heads or body parts, where the impact is unanticipated.

The second is the reported higher incidence of concussion in female footballers – 2.4 times higher in women than men participating in FIFA competitions. Data suggest intrinsic differences in the abilities of the female and male to withstand blows to the head. This may be related to the smaller neck girth in females resulting in greater head-neck segment acceleration and displacement.

Conclusion

Sports-related concussion management has evolved from the somewhat nebulous and eclectic guidelines of the 20th century. The series of international consensus statements since 2001 appear to not only have consolidated expert opinion into a more unitary model, but exponentially spurred research and interest in the field. Many questions remained

unanswered, particularly concerning the pathophysiology of mild traumatic brain injury and possible pharmacological interventions. This review of current concepts in concussion management highlights the need for ongoing education of lay and medical target groups, a support network within the sporting code, a structured clinical protocol incorporating a thorough history, serial clinical assessments and a graded return to play process. Where available, computerised neuropsychological testing is a useful adjunct and often the only objective representation of changes to the affected player's brain. Adopting international conventions in the management of South African sportspersons of all levels is in the best clinical interest of our players, will allow for a framework of practical research and help mitigate against the possible medicolegal consequences of poorly managed head injuries.

A full list of references (82) is available on request from jpat@mweb.co.za

In a nutshell

- Concussion in sport may present in a nebulous manner that has been open to subjective interpretation.
- Concussion may or may not present with loss of consciousness; other symptoms include amnesia and physical, cognitive, emotional and sleep symptom clusters.
- Although our understanding of its pathophysiology is incomplete, through a series of international consensus meetings, our clinical approach has become more uniform.
- The clinician's approach should include:
 - fieldside identification and safe player removal
 - an understanding of the indications for hospital referral and brain imaging
 - follow-up consultations based on the SCAT2 guidelines
 - an understanding of the role of neuropsychological testing
 - a graduated return-to-play protocol.
- Football-specific issues include the now disputed link between heading the ball and concussions, and the higher incidence of concussion in female footballers.