

CONCUSSION IN SPORT: PRACTICAL MANAGEMENT GUIDELINES FOR MEDICAL PRACTITIONERS

Concussion is a trauma-induced change in mental state that may or may not involve loss of consciousness.



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The hallmarks of concussion include confusion and loss of memory (amnesia).¹ This particular injury is common in rugby. The incidence of concussion during a single rugby season at a South African high school was reported as 21.5%. In another study, the prevalence of concussion was 50% in schoolboy rugby players, as the majority of mild head injuries in schoolboys are often not recognised and reported. A similar prevalence has been noted in adult rugby players. In the 1999 Super 12 rugby competition, the incidence of concussion was 20%, the most common injury for that competition. Concussion is not limited to rugby. American football, ice hockey and horse riding also have a significant incidence of concussion.

Traditionally, there has been a lack of universal agreement on a standard definition for concussion, making scientific research difficult.¹ Furthermore, there is controversy regarding the ideal management of concussion in sport and a lack of objective data guiding return-to-play decisions.¹ Sport organisations have relied on broad guidelines regarding head injury management and apply rigid, compulsory exclusion periods from sport depending on the injury grading and severity. Recently, significant advances and improvements in head injury management have been proposed at the First International Conference on Concussion in Sport, Vienna 2001.¹ 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 concussion evaluation.¹

CLINICAL SYMPTOMS OF CONCUSSION (TABLE I)

The monitoring of symptoms of concussion is important in order to manage the concussed player correctly. A player cannot return to sport while the symptoms of concussion are present. The only symptoms of concussion that have been scientifically validated in prospective studies are: loss of consciousness, headache, dizziness, nausea, blurred vision, attention deficit and amnesia.² Headaches while exercising are not confined to concussion, as up to 50% of athletes involved in collision sports may report some form of exercise-related headache.² A wide range of anecdotal symptoms have been reported by clinicians, including: irritability, vacant stare, emotional lability, mood and behavioural changes, sleep disturbance, sensitivity to light and noise, lethargy, impaired co-ordination and altered taste and smell.² How the presence of these symptoms affects the prognosis in concussion is unknown. There is also evidence to show that after apparent recovery from concussion, symptoms may recur if the athlete is subjected to physiological stress.² Therefore, return-to-play guidelines include incremental exercise testing to ensure that the concussed athlete does not develop a recurrence of symptoms during physiological stress.

Table 1. **Symptoms and signs of concussion**¹**Typical symptoms**

Headache
 Dizziness
 Nausea
 Unsteadiness/loss of balance
 Confusion
 Unaware of period, opposition, score of game
 Feeling 'dinged', stunned or 'dazed'
 Seeing stars or flashing lights
 Ringing in the ears
 Double vision

Physical signs

Loss of consciousness/impaired conscious state
 Poor co-ordination or balance
 Concussive convulsion/impact seizure
 Gait unsteadiness/loss of balance
 Slow to answer questions or follow directions
 Easily distracted, poor concentration
 Displaying unusual or inappropriate emotions
 Vacant stare/glassy eyed
 Slurred speech
 Personality changes
 Inappropriate playing behaviour
 Significantly decreased playing ability
 Nausea/vomiting

COMPLICATIONS OF CONCUSSION**Early complications****Intracranial space-occupying lesions.**

Concussion may be associated with damage to cerebral arteries and veins. Bleeding from these vessels may lead to epidural, subdural and intracerebral haematomas respectively. Signs of raised intracranial pressure have to be recognised immediately and treated surgically to decompress the brain.

Second-impact syndrome. Diffuse cerebral swelling is a rare, but well-recognised complication of minor head injury and occurs mainly in children and teenagers.³ Second-impact syndrome was first reported in American football players who died after relatively minor head injury.⁴ This injury may occur if a player returns to play prematurely following a previous head injury.⁴ Brain swelling

may still be present from the previous injury. A second blow results in further swelling, followed by loss of the brain's ability to control blood inflow (autoregulation). Cerebral blood flow increases rapidly and brain pressure rises uncontrollably, leading to cardiorespiratory failure and death.⁴

Impact convulsions. Convulsions (seizures) in collision sports are not uncommon, and can appear as a dramatic event. They characteristically occur within 2 seconds of impact, but are not associated with structural brain damage. The good outcome of these episodes and the absence of long-term cognitive damage reflect their benign nature, not warranting antiepileptic treatment and preclusion from contact sports.

Late complications

Delayed recovery after concussion. After concussion, an athlete may continue to have significant

impairment of overall brain function for a considerable period of time. During this time the athlete's higher intellectual functions are impaired and may require 3 - 6 weeks to recover.⁵ About 10% of concussed persons may develop prolonged disability characterised by poor concentration, slowness of thought, early fatigue, inaccurate memory, irritability, impaired judgment and disturbed perception. Attempts at mental work may cause headache. In one study, 79% of subjects complained of persistent headaches and 59% had memory difficulty 3 months after the initial minor head injury.⁵

Chronic traumatic head injury.

The possibility exists that repetitive minor head injury may cause chronic brain injury. Certainly there is growing concern that each episode of concussion may result in residual brain damage. This is most evident in the development of cognitive dysfunction in boxing, the degree of which is directly related to the number of bouts in a boxer's career. Cognitive deficits have also been documented in amateur, professional and retired soccer players, the hypothesis being that this is caused by frequently heading the ball. Genetic factors associated with the ApoE4 gene may also increase the risk of developing chronic brain injury in sport. Future research is needed to establish the severity of head injury which causes summation and how long that residual effect lasts. Thus, it would be responsible to document a player's cognitive function periodically and note whether any cognitive deficit is present.

CLINICAL APPROACH TO HEAD INJURY**Immediate management**

The aim of immediate management is stabilisation. Basic aspects of first aid involving cervical spine protection followed by airway, breathing and circulation evaluation take priority. Following this assessment, the team physician should decide whether the injured player is able to continue playing or is concussed and not fit to con-

Table II. **Post-concussion memory and confusion assessment: Maddock's questions⁶**

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

tinue the game. At the field a simple neuropsychological test can be administered. Maddock's questions assess recent memory and are sensitive in discriminating concussed and non-concussed players (Table II).⁶ The standard approach of asking orientation item questions (time, place and person) has been shown to be unreliable, as this component of cognitive function may be preserved in concussion. Other simple tests such as three-item recall or digit span to determine whether post-traumatic amnesia has resolved could be used.

It should be emphasised that the concussed player must be medically assessed as soon as possible following injury. It is not within the expertise of a physiotherapist, fitness trainer or non-medical person to manage concussion injury. The South African Rugby Football Union guidelines state, 'if in doubt sit them out', a useful adage to follow, but more importantly advises concussed athletes not to return to the field of play on that day. Lovell *et al.*² have shown that the athlete with the grade 1 concussion, who would traditionally be allowed to return to the field of play after 15 minutes, demonstrated impaired cognitive function for approximately 5 days, further validating the decision to not allow a player to return to the field of play.

Early management

The main aim of this assessment is to determine if there are urgent indications for referral to hospital (Table III). Best performed in a quiet medical room, this assessment involves a thorough history and neurological exami-

nation, noting any symptoms of concussion and excluding potentially catastrophic signs of intracranial injury. Following this, the team physician must decide if there is any indication to perform neuro-imaging. If the player has been unconscious for any period of time, it is recommended that either a CT or MRI scan be performed. If there are no indications for these investigations and the concussed player is discharged home, he/she should be in the care of a responsible adult who is in possession of a head injury evaluation form.

Late management

The aim is to determine whether the player has fully recovered from concussion and is able to return to play. This is best performed by combining a clinical assessment with neuropsychological

logical testing as an objective and scientifically valid means of assessing recovery.^{7,8} This is essential as post-concussion recovery rates vary between individuals. Some players may take days and others may take weeks to recover. Individual factors associated with each concussion injury are different and emerging evidence has hinted that genetic factors may be involved in both the response to head injury and recovery rates. There are dangers associated with universal mandatory exclusion criteria. It may be tempting to assume that a player has completely recovered from concussion as soon as the arbitrary time period has passed and that a medical assessment is not necessary, when in fact brain function is still abnormal. A detailed clinical symptom assessment of the concussed athlete is imperative. The symptoms can be clearly evident as the patient may freely volunteer this information, or the clinician may have to both ask specific questions to the athlete and gather collateral information from close family contacts in order to determine subtle mood or behavioural changes. A recent study has shown that post-concussion headache in high school athletes lasting longer than 1 week was associated with poor neurocognitive test scores, more other symptoms of concussion (anterograde amnesia) and may be a very impor-

Table III. **Indications for urgent referral to hospital for special investigations 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)

tant clinical marker of return to play. The clinician would certainly not allow athletes who are still demonstrating any symptoms of concussion to return to sport.

NEUROPSYCHOLOGICAL TESTING

A neuropsychological test is designed to assess the ability of the brain to process information (cognitive function). Traditional 'paper and pencil' tests, such as the Digit Symbol Substitution Test, have been replaced by computerised neuropsychological tests. 'Paper and pencil' tests may not be sensitive enough to detect abnormal cognitive function in concussed athletes.^{7,8} Computer tests are quick and easy to administer, show minimal learning effects and more importantly, are able to detect very subtle changes in cognitive function by measuring response variability, a feature not found with the 'paper and pencil' tests.^{7,8} Computerised tests are cost effective and easily accessible to a large number of players. A doctor can administer the test, as the aim of the test is to determine whether cognitive dysfunction is present and not the reason for abnormal function. It is recommended that a neuropsychologist is consulted if cognitive function is severe and cognitive function recovery is prolonged.

Examples of computerised tests include CogSport (CogState Ltd, Australia) and Impact (Impact Applications: University of Pittsburgh Medical Center). The South African Rugby Football Union uses the CogSport neuropsychological test, developed by leading concussion neuroscientists in Australia and peer-reviewed in the medical literature, as an objective measure of cognitive function following head injury.^{7,8} This test is able to measure performance variability, a key measure in concussion diagnosis.⁸ The test can be administered by team physicians and performed as part of a pre-season evaluation forming a baseline neuropsychological assessment. The baseline test ensures reliable comparative data, will aid in the detection of subtle cognitive impairment, eliminates the need to compare with 'nor-

mative data' and assists with accurate clinical decision-making. The baseline data also ensure that baseline performance is not adversely affected by disease, drugs, practice effects and malingering. A report detailing the players' response speed, accuracy and consistency is generated. The computerised cognitive test can be repeated following a head injury and compared to the athlete's own baseline computerised test to determine any deviation in cognitive function.

RETURN TO SPORT

A structured and supervised concussion rehabilitation protocol is conducive to optimal injury recovery and safe return to play.¹ Any return-to-play decision must be preceded by both clinical and cognitive recovery, simply because cognitive recovery often lags behind complete resolution of post-concussion symptoms. Following this, a graded rehabilitation programme is commenced. The end-point is a return to match competition. Return to play following concussion follows a stepwise process:

- No activity and complete rest until the player is asymptomatic.
- Neuropsychological test parameters return to baseline pre-season values.
- Exercise rehabilitation programme:
 - light aerobic exercise (walking and stationary cycling)
 - sport-specific training (running drills, ball handling skills)
 - non-contact drills
 - full-contact practice
 - game play.

The player can proceed in a stepwise progression to the level above provided he/she is asymptomatic. If any post-concussion symptoms develop, the player should drop back to the previous asymptomatic level. A minimum of 24 hours should elapse before progressing to the next step. The International Rugby Board (IRB) regulations state that all international players who adhere to the above protocol can return to play before the compulsory 3-week rest period has been completed. However all age group rugby players who are concussed have to rest from all rugby matches and

practices for the required 3-week rest period.

CONCLUSION

The ideal management of concussion in sport has been an enigma. The guidelines proposed by the world's leading concussion experts at the Vienna Conference and the South African Rugby Management Guidelines on Concussion, provide the team physician with a structured approach to concussion and the necessary tools to make sound judgment decisions regarding return to play. In professional sport, team physicians are not immune to litigation and this approach may afford the necessary medico-legal protection.

References available on request.

IN A NUTSHELL

Concussion is a common and serious injury occurring in contact sport.

Concussion is a disturbance of brain function and structural changes are rarely demonstrated on CT scan.

All concussed athletes should be medically evaluated at a formal trauma unit and a neurosurgical opinion obtained as soon after the injury as possible.

A significant number of athletes may take weeks for the symptoms of concussion to resolve.

Computerised cognitive function testing is a reliable, sensitive, and user-friendly means of assessing cognitive function, replacing traditional 'paper and pencil' tests.

Return-to-play decisions should ideally be individualised for a particular athlete and made by a multidisciplinary team of concussion experts including a sports physician, neurosurgeon, neuropsychologist and exercise therapist at an appropriate sports concussion centre.