SPORTS-RELATED CONCUSSION RELEVANT TO THE SOUTH AFRICAN RUGBY ENVIRONMENT – A REVIEW

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Providing coaches, referees, players, and administrators with the knowledge, skills, and leadership abilities to ensure that safety and best practice principles are incorporated into all aspects of contact rugby.
ABSTRACT

Guidelines for returning a concussed player to sport have been somewhat controversial and nebulous until the emergence of a series of international consensus meetings and statements initiated in 2001. The Vienna (2001), Prague (2004), American National Athletic Trainers Association (2004) and the American College of Sports Medicine (2005) statements have given the sports clinician better guidance and which is more evidence-based than the somewhat subjective guidelines of the late 20th Century. The major impetus to research and the re-evaluation of assessment and management guidelines has been provided by the emergence of computerised neuropsychological test batteries as a useful gauge of cognitive recovery. However, the clinical evaluation of a concussed player should incorporate a thorough symptom analysis, general, cognitive and neurological examination, and balance testing. In addition, and as an essential final stress test, the player must be subjected to a series of graded exercise sessions increasing in severity before being returned to contact or collision sport. A structured clinical evaluation is particularly important in the South African environment where computerised testing may not be accessible to many. This article serves to collate and highlight the evidence-based and consensus data available for management of the concussed rugby player.

Key Words: rugby football, concussion, computerised neuropsychological testing, return to play, cognitive impairment

INTRODUCTION

Concussion is a trauma-induced change in mental state that may or may not involve loss of consciousness. It is also referred to as mild traumatic brain injury. 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 (Table 1). Concussion is common in rugby football in South Africa. The incidence of concussion at high school level has been reported as 22%. In another study, the prevalence of concussion was reported as a much higher 50% in schoolboy rugby players, as the majority of mild head injuries are often not recognised and reported, especially in cases in which schoolboys are concerned. A similar prevalence has been noted in adult rugby players. In the 1999 Super 12 rugby competition, the incidence of concussion was reported as 20%, the most common injury for that competition.

Scientific research into many aspects of concussion has been impaired as much by differences in definition as by the ethical and practical issues involved in inducing and monitoring brain injury.
From this has stemmed controversy regarding the ideal management of concussion in sport and a lack of objective data guiding return to play decisions.\(^{(1)}\) This has resulted in sports organisations having to rely on broad, subjective guidelines for head injury management and applying rigid, compulsory exclusion periods from sport following a grading of the severity of injury which has depended on unvalidated grading systems. The last 7 years have seen a more collated approach to head injury management in sports persons. The watershed occurred 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 a comprehensive clinical concussion evaluation.\(^{(1)}\) Since then consolidation of the Vienna guidelines has taken place at the Second International Conference in Prague (2004),\(^{(52)}\) while the National Athletic Trainers Association (USA, 2004)\(^{(29)}\) and the American College of Sports Medicine (2005)\(^{(31)}\) have published clinical management guidelines based on these consensus meetings.

**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.\(^{(23)}\) The assumption is that similar changes occur in concussion.\(^{(33)}\) Immediately after biomechanical injury to the brain, abrupt, indiscriminant release of neurotransmitters and unchecked ionic fluxes occur. 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\(_1\)-K\(_1\)) pump works overtime. The Na\(_1\)-K\(_1\) 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 (Table 1) 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.\(^{(23, 33, 46)}\) Loss of consciousness that may occur with concussion is likely due to damage to the reticular activating system. The reticular activating system recovers relatively quickly and therefore consciousness is regained fairly soon after injury.\(^{(53)}\) The biochemical mismatch lasts significantly longer making loss of consciousness a poor indicator of severity of injury.
POTENTIAL COMPLICATIONS OF CONCUSSION

Early complications

Intracranial space occupying lesions:
Concussion may be, but is not usually, associated with damage to cerebral arteries and veins. Bleeding from these vessels may lead to epidural, subdural or intracerebral haematomas. (63, 73) 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. (2, 3) Second impact syndrome was first reported to occur in American Football players who died after relatively minor head injury. (6; 72) This injury may occur if a player returns to play prematurely following a previous head injury. Brain oedema and an increased vulnerability to injury during the biochemical “mismatch” described earlier may still be present from the previous blow. (23) A second blow results in further swelling, followed by loss of the brain’s ability to control blood inflow (autoregulation). (6) Cerebral blood flow increases rapidly and brain pressure rises uncontrollably leading to cardiorespiratory failure and possible death. (6)

Impact convulsions:
Convulsions (seizures) in collision sports are not common, but can appear as a dramatic event. (57) They characteristically occur within 2 seconds of impact, but are not necessarily associated with structural brain damage. (57) The good outcome with these episodes and the absence of long-term cognitive damage reflect the benign nature of these episodes, not necessarily warranting antiepileptic treatment and prolonged preclusion from contact sports. (57)

More enduring complications

Prolonged Post Concussion Syndrome:
The clusters of symptoms manifesting after a concussive blow may persist for days to weeks. (1, 75) The consequences of symptoms such as headache, dizziness, memory loss and fatigue are particularly significant in young people who have who may be in a learning environment, making decisions concerning rest from cognitive as well as physical stresses important.

Chronic traumatic encephalopathy:
This condition reflects the cumulative effect of long term exposure to repeated concussive and sub-concussive blows. (55) Certainly there is growing concern that each episode of concussion may result in residual brain damage possibly associated with the cerebral deposition of abnormal Tau protein. (26, 27, 37, 68) 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.\(^{(35, 36)}\) The cerebral damage that may occur in rugby players is thought to be largely cortical and more subtle than the cerebellar and basal ganglia manifestations of *dementia pugilistica*. Cognitive deficits have also been documented in amateur, professional and retired soccer players.\(^{(48, 49, 77, 78)}\) Genetic factors, associated with the ApoE4 gene, may also increase the risk of developing chronic brain injury in sport.\(^{(31-33, 38, 39)}\) Future research will need to establish what severity of head injury causes summation and how long that residual effect may last.\(^{(1)}\) Thus, it would be responsible clinical practice to document a player’s cognitive function periodically and note whether any cognitive deficit is present.

**The risk of a second concussion:**
Players with a past history of concussion may be at increased risk of subsequent concussion.\(^{(16, 21)}\) This however remains controversial and it seems that certain players display a high risk playing technique (tackling head on) that places them at increased risk of concussion. The risk of concussion is a feature of any collision sport and is directly related to the amount of time spent actually playing the sport. Therefore, the chance of repeat concussion may reflect the level of exposure to injury risk.\(^{(53)}\)

**Concussion Grading**
The grading of the severity of concussion is controversial. There have been at least 16 different classification systems for head injury severity described.\(^{(57)}\) All classification systems, except the Glasgow Coma Scale designed for the assessment of severe head trauma, are based on anecdotal evidence and not scientifically validated.\(^{(4, 5, 22, 40, 46, 62, 64, 65, 69, 71, 80)}\) The two most commonly used grading systems in sport have been the Cantu and Colorado guidelines (Table 2).\(^{(4, 17)}\) However, there are a number of practical difficulties with concussion scales. Firstly, it may be impossible to be certain that loss of consciousness has occurred as it may be momentary and by the time the medical attendant reaches the player, the player may appear only dazed.\(^{(56)}\) Secondly, there are also inconsistencies between these scales in terms of return-to-play guidelines. A first time concussion associated with a loss of consciousness for less than 5 minutes correlates with a Cantu grade 2 injury and results in the player missing 1 week of play. The same injury correlates with a Colorado grade 3 injury and the player is rested for a minimum of 1 month.\(^{17}\) This may result in coaches and team physicians utilising the injury scale that suits their needs but which may not be the best medical management for the player. Also, as mentioned earlier, loss of consciousness is a poor prognostic indicator. Cognitive (thinking) impairment may be as severe in a player who has lost consciousness compared to a player who has not.\(^{(42)}\) Therefore basing return-to-play decisions on the presence of loss of consciousness is inaccurate. Moreover, post-traumatic amnesia can only be determined retrospectively and is of little use for the on-field evaluation.\(^{(56)}\) The concept of traditional mandatory exclusion periods based on the above injury grading is not helpful and are based on data from motor
vehicle accidents.\textsuperscript{(25, 30)} The lack of validity of grading systems in a sporting milieu has lead to a move away from such dogmatic guidelines to a more individualised approach.

**THE PREVENTION OF CONCUSSION**

The brain is not an organ that can be trained to withstand injury, therefore extrinsic means of injury prevention need to be sought. The use of protective equipment has been advocated to reduce the risk of concussion in rugby. However, recent evidence disputes the effectiveness of International Rugby Board approved headgear preventing concussion.\textsuperscript{(58, 59, 60)} Interestingly, although rugby players believed that wearing headgear prevented concussion, very few reported wearing headgear.\textsuperscript{(56)} Evidence for the use of mouthguards preventing concussion is inconclusive, but they are advocated for the preventing oral and dental injuries.\textsuperscript{(19, 53, 54)} It is postulated that custom fitted mouthguards may decrease forces transmitted to the brain via absorption of impacts to the mandible, distraction of the temporomandibular joint and tensing of the neck muscles from biting down on the guard, resulting in decreased acceleration of the cranium on the neck. It has also been suggested that strengthening and conditioning of the neck muscles, together with rule changes, may also reduce the incidence of concussion.\textsuperscript{(5)} Again, further research data are needed to confirm this.

**Clinical approach to head injury management**

The international concussion consensus statements largely concur on an approach to the concussed player incorporating the following important aspects:\textsuperscript{(1, 29, 31, 52)}

- Clinical history
- Clinical examination
- The role of neuropsychological testing
- The role of neuro-imaging
- Education
- Prevention
- Future research
- Medico legal considerations

Any regional or national concussion initiative should therefore address these important areas.
Chronological approach to the clinical management of the concussed player:

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. (56) This applies especially in all cases where there has been loss of consciousness, the player is confused or has any suggestion of associated neck injury (neck pain, numbness or limb paraesthesiae). (29, 31) 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 are sensitive in discriminating between concussed and non-concussed players (Table 3). (43, 44, 81) The standard approach of asking orientation item questions (time, place and person) are unreliable, as this component of cognitive function may be preserved in concussion. (44, 51) The concussed player must be removed from the field of play or practice session immediately. (1, 29, 31)

Field side
It should be emphasised that the concussed player must be assessed by a medical doctor as soon as possible following injury. (56) The main aims of the field side assessment are to confirm the diagnosis of concussion, perform an initial (baseline) symptom analysis and to determine if there are urgent indications for referral to hospital (Table 4). (29, 56) This assessment is best performed in a quiet medical room as it involves a thorough history and neurological examination, noting any symptoms of concussion and excluding potential catastrophic signs of intracranial injury. The most practical tool for this assessment is the Sports Concussion Assessment Tool or SCAT card. This is a combination of internationally utilised clinical concussion assessment tools formatted into a user-friendly card format. (52) The original card (Figure 1) has been modified for use in South African rugby (Figures 2 & 3). Following this assessment, 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 5).

Hospital referral and brain imaging
The results of standard brain imaging techniques are almost always normal in concussed players. (1, 31, 52) 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 the player be referred to a tertiary care hospital and either a Computed Tomographic or Magnetic Resonance Image scan be performed. (56) 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 be discharged home in the care of a responsible adult who is in possession of a head injury advice form (Table 4). (56)
Follow-up consultation

Return-to-play decisions require serial medical evaluations and should not be made after the initial field side and/or emergency room evaluations. This is one of the central tenets of modern concussion management protocol. (1, 29, 31, 52)
The evaluations should preferably be performed by a clinician (sports medicine physician, neurologist and neuropsychologist) with experience in concussion management and au fait with recommended guidelines. To facilitate this, Sports Concussion South Africa has introduced the concept of the “Sports Concussion Centre”, a multi-disciplinary 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. \(^{41}\) Co-ordination of a player’s management by a neuropsychologist alone or via internet or telephonic consultation is deemed clinically inappropriate and treacherous from a medico legal perspective. \(^{1, 29, 31, 52, 42}\) However, best clinical practice dictates that medical doctors include a neuropsychologist as part of the multidisciplinary team making return-to-play decisions, particularly where computerised screening tests reveal significant, persistent or recurrent discrepancies in psychometric function.
The aim of serial evaluations 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 testing as an objective and scientifically valid means of assessing recovery. The clinical examination remains the most significant and universally accessible part of the assessment. The advantage of serial assessments is that comparison with previous visits becomes possible and a trend of a player’s recovery emerges. 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 \(^{(29)}\)

• Cardiovascular status – blood pressure, pulse

• Neurological status
  - Cranial nerves
  - Motor function
  - Sensory function
  - Cerebellar function

• Associated injuries especially involving the neck

A well-formatted standard assessment protocol is best suited for this purpose. To this end the Acute Concussion Evaluation form devised by Gioia and Collins and used by the Center for Disease Control has been modified for South African purposes.\(^{(24)}\)

**Neuropsychological testing**

Post-concussion recovery rates vary between individuals.\(^{(20, 23, 28, 30, 36)}\) 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 suggested that genetic factors may be involved in both the response to head injury and recovery rates.\(^{(1, 31-33)}\) 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 an arbitrary time period has passed and that a medical assessment is not necessary. However, it is conceivable that brain function, as measured by neuropsychological evaluation, is still abnormal after this arbitrary time period has passed.\(^{(7)}\)

A neuropsychological test is designed to assess the ability of the brain to process information (cognitive function).\(^{(8, 34, 74)}\) Traditional “paper and pencil” tests, such as the Digit Symbol Substitution Test, have been replaced by more practically applied computerised neuropsychological tests.\(^{(8, 9)}\) Computer tests are quick and easy to administer, show fewer 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.\(^{(13, 14, 18)}\) Computerised tests are cost effective and easily accessible to a large number of players.\(^{(7)}\) The tests are designed for medical doctors to
administer, as the aim of the test is to determine whether cognitive dysfunction is present and is not designed to determine the reason for abnormal function. (7)

Examples of computerised tests include Automated Neuropsychological Assessment Metrics (ANAM), CogState Sport, Headminders and the Immediate Post-concussion Assessment and Cognitive Testing (ImPACT). The South African Rugby Union has utilised the CogState Sport (previously Cogsport) neuropsychological test. This test was developed by leading concussion neuroscientists in Australia as an objective measure of cognitive function following head injury and has been published in the medical literature. (10-15) This test is able to measure performance variability, a key measure in concussion diagnosis. (11) The test can be administered by team physicians and performed as part of a pre-season evaluation forming a baseline neuropsychological assessment. Of significant use in the application of neuropsychological testing is this preseason test. These pre-injury data ensure more reliable comparisons with post-concussion assessments, (31, 52) will aid in the detection of subtle cognitive impairment, eliminate the need to compare to ‘normative data’ and assist with accurate clinical decision-making. The baseline data also ensure that test performance is not adversely affected by disease, drugs, practice effects and malingering. (11, 15, 18, 43) A report detailing the player’s response speed, accuracy and consistency is generated. The test can be repeated following a head injury to determine whether cognitive function has deviated from baseline. (7, 8) The benefits are that the player returns to play after having recovered from a symptom and cognitive function perspective and has the ability to perform sports-specific skills optimally. Newer protocols suggest the player should not be tested whilst symptomatic as this may induce unnecessary cognitive stress, possibly increase the chances of a practice effect and not alter the immediate management of the player. (31, 52) Issues of cost and accessibility may prevent the use of computerised tests and concussion management protocols should be able to be implemented without their use. (31)

A neuropsychologist, as part of the multi-disciplinary sports concussion team, should be consulted if cognitive function is severe and prolonged (7), in cases of recurrent concussion over a short period, in players who appear to suffer concussion with relatively minor impacts, where neurological or psychological co-morbidity 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. (16) 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 PROTOCOL

The final phase of a safe, structured and supervised concussion rehabilitation protocol involves the progressive exposure of the recovering player to increasing degrees of exercise intensity whilst monitoring symptoms. This process should be preceded by the recovery of both the clinical and cognitive symptoms. 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 end point is a return to match competition. Return to play following concussion follows a stepwise process.

1. No activity and complete rest until the player is asymptomatic.
2. Neuropsychological test parameters return to baseline pre-season values or are comparable to age-appropriate norms.
3. Exercise rehabilitation program:
   4. Light aerobic exercise (walking and stationary cycling)
   5. Sport specific training (running drills, ball handling skills)
   6. Non-contact drills
   7. Full-contact practice
   8. Game play

The player can proceed in a stepwise progression to the next level after 24 hours, provided he/she is asymptomatic. If any post-concussion symptoms develop, the player should revert back to the previous asymptomatic level.

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 potential for influencing the neurometabolic cascade postulated as being central to the pathophysiology, include corticosteroids, calcium channel blockers, anti-oxidants, glutamate receptor antagonists, 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), 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 for them influencing the pathophysiology of concussion. Moreover, treatments to manage more prolonged post-concussive symptoms should be monitored by the broader team of clinicians including neurologists and neuropsychologists.

EDUCATION AND RESEARCH

Each of the important consensus documents has emphasised the need for education of the sporting public (i.e. players, parents, coaches, referees and administrators) and the medical fraternity about the nature of concussive injury and best management principles. (1, 29, 31, 52) This can be provided by lectures and circulating brochures, posters, and information on relevant websites that describe the protocols.

CONCLUSION

Sports-related concussion management appears to have partially emerged 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 remain 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 rugby players 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 medico legal consequences of poorly managed head injuries.
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Dr Kohler is a sports physician based in Cape Town and Chief Medical Officer of the Western Province Rugby Union and Stormers Super 14 Rugby.

Dr Patricios and Dr Kohler are co-founders of the Pharos Sports Concussion Programme and Sports Concussion South Africa.

REFERENCES


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### TABLE 1. SYMPTOMS AND SIGNS OF CONCUSSION

<table>
<thead>
<tr>
<th>PHYSICAL</th>
<th>COGNITIVE</th>
<th>EMOTIONAL</th>
<th>SLEEP</th>
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</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Poor concentration</td>
<td>Depression</td>
<td>Drowsiness</td>
</tr>
<tr>
<td>Photophobia</td>
<td>Problems remembering</td>
<td>Irritability</td>
<td>Insomnia</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Feeling “foggy”</td>
<td>Mood swings</td>
<td>Sleeping more</td>
</tr>
<tr>
<td>Phonophobia</td>
<td>Feeling “slowed down”</td>
<td>Aggressiveness</td>
<td>Difficulty getting to sleep</td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Numbness/tingling</td>
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<tr>
<td>Vomiting</td>
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<tr>
<td>Fatigue</td>
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<tr>
<td>Visual changes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Balance problems</td>
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</tbody>
</table>
### TABLE 2: PREVIOUS SEVERITY OF CONCUSSION CLASSIFICATION AND RETURN TO PLAY RECOMMENDATIONS.\(^{4,17}\)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>RETURN TO PLAY RECOMMENDATION</th>
<th>CANTU GUIDELINES(^4)</th>
<th>COLORADO GUIDELINES(^17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 (mild)</td>
<td>May return to play when asymptomatic</td>
<td>No LOC*</td>
<td>Confusion, no amnesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTA** &lt; 30 min</td>
<td>No LOC</td>
</tr>
<tr>
<td>Grade 2 (moderate)</td>
<td>Return if asymptomatic for 1 week</td>
<td>LOC &lt; 5 min</td>
<td>Confusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTA &gt; 30 min</td>
<td>with amnesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No LOC</td>
</tr>
<tr>
<td>Grade 3 (severe)</td>
<td>May return after 1 month, if asymptomatic for 2 weeks</td>
<td>LOC &gt; 5 min</td>
<td>LOC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTA &gt; 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

* LOC- loss of consciousness

** PTA- post-traumatic amnesia

### TABLE 3: MADDOCK’S QUESTIONS \(^{44}\)

- 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?
TABLE 4: INDICATIONS FOR URGENT REFERRAL TO HOSPITAL FOR SPECIAL INVESTIGATION AND ADMISSION.\(^{(1)}\)

<table>
<thead>
<tr>
<th>Any player who has or develops the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fractured skull</td>
</tr>
<tr>
<td>• Penetrating skull trauma</td>
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<tr>
<td>• Deterioration in conscious state following injury</td>
</tr>
<tr>
<td>• Focal neurological signs</td>
</tr>
<tr>
<td>• Confusion or impairment of consciousness &gt; 30 minutes</td>
</tr>
<tr>
<td>• Loss of consciousness &gt; 5 minutes</td>
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<tr>
<td>• Persistent vomiting or increasing headache post injury</td>
</tr>
<tr>
<td>• Any convulsive movements</td>
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<tr>
<td>• More than one episode of concussive injury in a match or training session</td>
</tr>
<tr>
<td>• Where there is assessment difficulty (e.g.: an intoxicated patient)</td>
</tr>
<tr>
<td>• All children with head injuries</td>
</tr>
<tr>
<td>• High-risk patients (e.g. haemophilia, anticoagulant use)</td>
</tr>
<tr>
<td>• Inadequate post injury supervision</td>
</tr>
<tr>
<td>• High-risk injury mechanism (e.g.: high velocity impact, missile injury)</td>
</tr>
</tbody>
</table>
TABLE 5. PATIENT DISCHARGE INFORMATION FOR 48 HOURS AFTER INJURY

Patient Information - Important Reminders for the First 48 Hours

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 & 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.*