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Updated guidelines for the management of sports-related concussion in general practice

Background

Concussion is common in many sports and recreational activities. It is thought to reflect a functional rather than structural injury to the brain. The clinical features are typically short-lived and usually resolve spontaneously. Complications, however, can occur and may include prolonged symptoms and/or cognitive deficits in the short term, as well as depression and cumulative deterioration in brain function in the longer term.

Objective

This article will provide an updated clinical review of concussion in sport, with an emphasis on assessment and management in general practice.

Discussion

The critical issues in the clinical management of concussion in sport include making a diagnosis, differentiating between concussion and other pathologies (particularly structural head injury), recognising the presence of any modifying factors (which may increase the risk of complications) and determining when the patient can safely return to competition. The key components of safe return-to-play decisions include rest, neuropsychological testing and a graded program of exertion before return to sport.

Keywords

brain injuries; central nervous system diseases; brain concussion; sports medicine



Concussion is a common problem in many sports and recreational activities, especially those involving body contact, collisions or high speeds. Recent reports from the United States estimate 1.6–3.8 million cases of sport- and recreation-related traumatic brain injury each year.¹ In Australia, common participation sports such as Australian Rules football, rugby league and rugby union have amongst the highest rates of head injury of any team sports in the world. The reported incidence of concussion in these sports ranges from about 3–10 concussive injuries per 1000 player hours,^{2–4} which equates to an average of five injuries per team per season, regardless of the level of competition. This represents a significant public health issue in active communities.

In general practice, concussion can present in a number of different ways. The general practitioner (GP) may be the initial point of contact in the acute setting following head trauma. More commonly, patients present some time after their head injury either with ongoing symptoms or for medical clearance to allow them to return to play. To manage these clinical scenarios, it is important to have a good understanding of concussion in sport and current management recommendations.

Since 2001, four international conferences have been held to address key issues in the understanding and management of concussion in sport. After each of these meetings, a summary document was published to 'improve the safety and health of athletes who suffer concussive injuries during participation in sport'.^{5–8} The most recent conference was held in Zurich in November 2012. The consensus statement from the Zurich meeting provides the most up-to-date knowledge on concussion in sport.⁸ It also outlines the current best practice management guidelines and provides practitioners with simple clinical tools to help manage a concussion. Some of the key concepts that arose from the 2012 Zurich meeting include:

- a focus on improved recognition and reporting of concussion
- an emphasis on a conservative management approach, especially on the day of injury, and in children, where the priority is return to school and learning, rather than return to sport.

The aim of this paper is to provide an updated overview on concussion in sport, including an understanding of the injury, an

**Table 1. Summary of complications associated with concussion in sport**

Complication	Comments
1. Impaired performance and increased risk of injury on return to play	Return to play with ongoing cognitive deficits, such as slowed reaction times, may result in impaired performance or predispose the individual to increased risk of injury, including repeated concussion. ²⁴
2. Acute, progressive diffuse cerebral oedema	Also referred to as 'second impact syndrome' due to a possible association with repeated head trauma. ²⁵ Typically occurs rapidly after single head impact in most published cases. ²⁶ Pathophysiology may involve disordered autoregulation.
3. Prolonged symptoms	Long recognised complication of mild traumatic brain injury. ²⁷ Prospective cohort studies monitoring clinical recovery following concussion show that 5–10% of concussed athletes take >10 days to recover; <1% have true 'post-concussion syndrome' (i.e. symptoms lasting >3 months). ²⁸
4. Depression and other mental health issues	A cross-sectional study in retired football players showed a 2–3-fold increase in relative risk of clinical depression. ¹³
5. Cumulative cognitive deficits (chronic traumatic encephalopathy, CTE)	Recurrent head trauma has been implicated in progressive deterioration in brain function. Cross-sectional studies have shown that cognitive performance is lower in individuals with previous concussions than in controls. ²⁹ Some athletes also have persistent cognitive deficits post-concussion. ³⁰ Case reports and cross-sectional studies have reported CTE in elite American football players. ^{11–14} May be related to genetic predisposition. ¹⁰

outline of potential risks and an overview of current management guidelines, particularly as they relate to general practice.

What is concussion?

Concussion is defined as a 'complex pathophysiological process affecting the brain, induced by biomechanical forces'.⁸ It is characterised by a graded set of neurological symptoms and signs that typically arise rapidly and resolve spontaneously over a sequential course. The process of recovery, however, varies from person to person and injury to injury.

The pathophysiology of concussion is not well understood. The current consensus is that the injury reflects a physiological disturbance (eg. neurochemical, metabolic or gene expression changes)⁹ rather than a structural injury to the brain.⁸

What are the potential complications of concussion in sport?

Most cases of concussion in sport recover uneventfully within 10–14 days of injury; however, a number of complications have been reported. These are summarised in *Table 1*. Risk factors for complications or adverse outcomes following concussion in sport remain unclear. There is a suggestion that genetic factors may have an important role,¹⁰ but the current consensus is that premature return to play (and subsequent second injury before the athlete has fully recovered from the initial concussion) may predispose to poorer outcomes.⁸

The role of recurrent head trauma in the development of potential long-term complications, such as depression and chronic traumatic encephalopathy (CTE), has received considerable attention in the scientific and lay press in recent years. Pathological case reports and

cross-sectional studies have suggested that retired National Football League (NFL) footballers who have had recurrent head trauma during their careers suffer disproportionately from cognitive impairment, depression and other mental health problems.^{11–14} At this time, however, very little is known about what type, frequency or amount of trauma is necessary to induce the accumulation of pathological proteins (eg. Tau reported in cases of CTE) and, more importantly, why only some athletes are at risk of CTE. Nevertheless, this concern should reinforce the need for conservative management strategies designed to ensure player safety.

How do we manage concussion in sport?

The critical issues in the clinical management of concussion in sport include making a diagnosis, differentiating between concussion and other pathologies (particularly structural head injury), recognising the presence of any modifying factors (*Table 2*), which may increase the risk of complications and determining when the patient can safely return to competition.

Making a diagnosis

Diagnosis of concussion can be difficult because:

- clinical symptoms and signs can change rapidly and may evolve over time
- many of the clinical features (especially symptoms) are not specific to concussion
- there is no reliable test or marker for an objective diagnosis.

Consequently, the diagnosis of concussion remains a clinical decision based on assessment of a range of domains including



Table 2. Concussion modifiers

Factors	Modifier
Symptoms	High number, long duration (>10 days), high severity
Signs	Prolonged loss of consciousness (>1 min), amnesia
Sequelae	Prolonged convulsive convulsions*
Temporal	Frequency: repeated concussions over time Timing: injuries close together in time 'Recency': recent concussion or traumatic brain injury
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (<18 years)
Co- and pre-morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder, learning disabilities, sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behaviour	Dangerous style of play
Sport	High-risk activity, contact and collision sport, high sporting level
<p>*Convulsive convulsions or impact seizures are occasionally observed following concussion in sport. These are usually brief in duration (<1 minute) and range from tonic posturing to full tonic-clonic seizures. Brief convulsive convulsions are benign and have no adverse clinical outcomes.³¹ Consequently, investigations are not required, anti-epileptic treatment is not indicated and prolonged absence from sport is not warranted in most cases.^{32,33} Adapted with permission from BMJ Publishing Group Limited from McCrory P, Meeuwisse WH, Aubry M, et al. Br J Sports Med 2013;47.⁸</p>	

symptoms (eg. headache, difficulty concentrating, feeling like being in a fog, emotional lability, etc), signs (eg. loss of consciousness, balance disturbance), cognitive impairment (eg. confusion, slowed reaction times) and neurobehavioural changes (eg. irritability, feeling 'not quite right').

The clinical history is important. Common symptoms of concussion include headache, nausea, dizziness and balance problems, blurred vision or other visual disturbance, confusion, memory loss and a feeling of slowness or fatigue. Most symptoms appear rapidly after a concussive incident but some symptoms may be delayed. The diagnosis should be suspected in any patient who presents with any of these symptoms after direct trauma to the head or a collision (where forces can be transmitted to the brain).

Clinical features that are more specific to a diagnosis of concussion include loss of consciousness, confusion or attention deficit, memory disturbance and balance disturbance; however these features may not be present in all cases. Questioning close relatives, especially parents or guardians in the case of children and adolescents, is often valuable. Any report that the individual 'does not seem right' or 'is not themselves' after trauma, is strongly suggestive of a concussive injury.

The use of a graded symptom checklist is often helpful. The advantages of the symptom checklist are that it covers the range of symptoms commonly observed after concussion and provides a measure of symptom severity. The latest consensus statement on the management of concussion in sport includes a comprehensive Standardized Concussion Assessment Tool, 3rd edition (SCAT3) to facilitate assessment of athletes who have had a concussive incident.⁸ The SCAT3 includes a detailed graded symptom checklist.

If video footage of the incident is available (eg. from video camera, mobile phone camera, etc), reviewing the footage may provide the clinician with important information regarding the mechanism of injury and the presence of acute signs (eg. loss of consciousness, impaired balance, impact seizure, etc).

Differentiating concussion from structural pathologies

Clinical features that may raise concerns of structural head injury include:

- the mechanism of injury, particularly if there is a high velocity of impact or collision with an unyielding body part (eg. head to knee impact)
- immediate and/or prolonged loss of consciousness
- examination finding of a focal neurological deficit or
- progression of clinical features over time. Clinical features of concussion typically resolve within 10–14 days of injury. Any deterioration in clinical state, such as worsening headaches, nausea or vomiting, or deterioration in conscious state, particularly in the acute setting, should raise suspicion of a structural head injury and warrant urgent investigation. Similarly, structural head injury should be considered in any case where symptoms persist for more than 10–14 days.

In a concussed individual with any of the adverse warning signs listed above, urgent computerised tomography (CT brain scan) is required to exclude intracranial haemorrhage. After an uncomplicated concussion, however, conventional imaging techniques such as skull X-ray, CT brain scan and magnetic resonance imaging (MRI) of the brain are usually normal.



Modifying factors

A range of clinical factors that may be associated with longer duration of symptoms or increased risk of adverse outcomes following concussion have recently been reviewed.¹⁵ These modifying factors are summarised in *Table 2*.

The presence of any modifying factor after a concussive injury requires a more conservative approach, including more detailed assessment and slower time to return to sport. In difficult or complicated cases, consideration should also be given to a multidisciplinary team approach (including referral to a neuropsychologist and/or doctor with expertise in managing concussion).

Determining when the patient can return safely to competition

Any player with a suspected or confirmed concussion is not to be returned to play (or training) on the day of their injury. The decision regarding the timing of return to play following a concussive injury is a difficult one to make. Expert consensus guidelines recommend that players should not be allowed to return to competition until they have recovered completely from their concussive injury.⁵⁻⁸ Currently, however, there is no single gold standard measure of brain disturbance and recovery following concussion in sport. Instead, clinicians must rely on indirect measures to inform clinical judgement. In practical terms, this involves a comprehensive clinical approach, including:

- a period of cognitive and physical rest to facilitate recovery
- monitoring post-concussion symptoms and signs to assess recovery
- the use of neuropsychological tests to estimate recovery of cognitive function
- a graduated return to activity with monitoring for recurrence of symptoms.

a) A period of cognitive and physical rest to facilitate recovery

Early rest after a concussive injury is important to allow recovery. Physical activity, physiological stress (eg. altitude and flying) and cognitive loads (eg. school work, video games, computer) can all worsen symptoms and possibly delay recovery after a concussion.⁸ Individuals should be advised to rest from these activities in the early stages after a concussive injury, especially while symptomatic (see 'concussion injury advice' page 4 of SCAT3).⁸ Similarly, the use of alcohol, sedatives or recreational drugs can exacerbate symptoms following head trauma, delay recovery or mask deterioration and should also be avoided. Specific advice should be given on avoidance of activities, such as driving, that place the individual at risk of further injury.⁸

b) Monitoring post-concussion symptoms and signs to assess recovery

Monitoring post-concussion symptoms and signs can be facilitated by the use of the SCAT3.⁸ This tool represents a standardised method

of evaluating individuals after a concussive injury. It provides a multifaceted clinical assessment, consisting of a graded symptom checklist, clinical tests of balance and a basic cognitive assessment.⁸

c) Use of neuropsychological tests to estimate recovery of cognitive function

Cognitive deficits associated with concussion are typically subtle and may exist in a number of domains. Common deficits that follow concussion in sport include reduced attention and ability to process information, slowed reaction times and impaired memory.¹⁶⁻¹⁹ The use of neuropsychological tests in the management of concussion overcomes the reliance on subjective symptoms, which are known to be poorly recognised and variably reported,²⁰⁻²² and allows detection of cognitive deficits, which have been observed to outlast symptoms in many cases of concussion.¹⁷

Formal neuropsychological testing remains the clinical standard for the assessment of cognitive function. Formal testing is recommended in any case where there is uncertainty about recovery or in difficult cases (eg. prolonged recovery). For practical purposes, screening neuropsychological tests can be used for assessment of cognitive recovery. Ideally, the tests should be compared with the individual's own pre-injury baseline. In cases where a baseline does not exist, which is often the case in general practice, the test result can be compared with population normative data.

A number of screening neuropsychological tests have been validated for use following concussion in sport and are readily available. These include computerised test platforms such as Axon Sports (www.axonsports.com) or ImPACT (www.impacttest.com). In cases where the concussion has resulted in brief symptoms and clinically the player has recovered well, basic paper-and-pencil cognitive tests can be used to provide an estimate of cognitive function (eg. SCAT3). The use of a basic paper-and-pencil evaluation should be combined with a conservative return-to-play approach and careful monitoring of symptoms as the player progresses through a graduated return to play program.

Overall, it is important to remember that neuropsychological testing is only one component of assessment, and therefore should not be the sole basis of management decisions. Neuropsychological testing does not replace the need for a full history and clinical/neurological examination.

d) A graduated return to activity with monitoring for recurrence of symptoms

After a concussive injury, players should be returned to play in a graded fashion (*Table 3*) once clinical features have resolved and cognitive function returned to 'normal' on neuropsychological testing. Overall, a more conservative approach (ie. longer time to return to sport) should be used in cases where there is any uncertainty about the player's recovery ('if in doubt sit them out'). Progression through the rehabilitation program should occur with 24 hours between stages. The player should be instructed that if any symptoms recur while



Table 3. Graduated return-to-play protocol

Rehabilitation stage	Functional exercise	Objective
1. No activity	Symptom-limited physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity at <70% maximum predicted heart rate No resistance training	Increase heart rate
3. Sport-specific exercise	Light training drills (eg. running, ball work, etc). No head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills. May start progressive resistance training	Exercise, coordination and cognitive load
5. Full contact practice	Participation in normal training activities after medical clearance	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

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progressing through their return-to-play program that they should drop back to the previous asymptomatic level and try to progress again after a further 24 hours of rest.

How does the management of concussion differ in children?

There is evidence that younger athletes take longer to recover after a concussive injury than adults and that return to play on the day of the injury leads to subsequent cognitive deterioration.²³ Moreover, there are specific risks (eg. diffuse cerebral swelling) related to head impact during childhood and adolescence. Consequently, a more conservative approach is recommended in all concussed footballers under the age of 18 years, regardless of the level of competition in which they participate.

The diagnosis of concussion, monitoring concussive symptoms, and physical and cognitive assessment must be modified in children because of physical, cognitive and language development. As such a childSCAT3 has been developed for use in children aged 5–12 years.⁸ For children aged 13–18 years, the SCAT3 should be used. It should be noted that the childSCAT3 includes both a child-report and parent-report symptom scale. It is very important to include the parent/teacher/coach/guardian in assessing the child with concussion.

Once the diagnosis of concussion has been made, the priority for children is successful return to learn and return to school before considering return to play. Therefore, the child requires medical clearance before return to school. In most instances, the child will only require absence from school for 1–2 days; however, in others, longer periods of rest will be required. When the child's symptoms are no longer exacerbated by reading or using the computer, the child may return to school. However, a careful plan will need to be developed for the parents and teachers that provides appropriate accommodations for the child, such as shorter school days, longer time to complete assignments, repeating instructions and frequent breaks (see page

4 of the childSCAT3). Only after successful return to school without worsening of symptoms may the child be allowed to commence return to sport.

Summary

Concussion in sport reflects a functional disturbance rather than a structural injury to the brain. Although most individuals recover uneventfully after a concussive injury, complications can occur, particularly with premature return to sport. The key components of safe return-to-play decisions include rest until all symptoms have resolved, neuropsychological testing to ensure objective recovery of cognitive function and then a graded program of exertion before return to sport. In difficult or complicated cases, a multidisciplinary approach to management should be considered.

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Resources

- SCAT3. Available at bjsm.bmj.com/content/47/5/259.full.pdf [Accessed 30 January 2014].



- Child SCAT3. Available at bjsm.bmj.com/content/47/5/263.full.pdf [Accessed 30 January 2014].

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