

Concussion in sport



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The critical components of management of concussion include making an accurate diagnosis and determining when players have recovered so that they can safely return to competition.

MedicineToday 2011; 12(7): 75-82

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Head trauma is a common occurrence in many sports and recreational pursuits. Recent figures from the USA estimate approximately 1.6 to 3.8 million cases of sports- and recreation-related head injury each year.¹ In Australia, common participation sports such as Australian rules football, rugby league and rugby union have high rates of head injury. The reported incidence of concussion in these sports is in excess of five concussive injuries per 1000 player hours,²⁻⁴ which equates to over five concussions per team per season.

Over the past eight years, three conferences have been held in which the world leading experts have addressed key issues in the understanding and management of concussion in sport.⁵⁻⁷ Following each of these meetings, a summary and agreement statement have been published with an aim to 'improve the safety and health of athletes who suffer concussive injuries during participation in sport'.⁵⁻⁷ The most recent conference was held in Zurich, Switzerland, in November 2008. The consensus statement produced from this meeting provides the most up-to-date knowledge on concussion in sport, and outlines the current best practice management guidelines.⁷

This article aims to provide an overview of the key concepts arising from the conferences on concussion in sport, including an understanding of the injury, an outline of potential risks and an overview of current management guidelines.

WHAT IS CONCUSSION?

Concussion can be defined as a clinical syndrome of neurological impairment that results from traumatic biomechanical forces transmitted to the brain (either directly or indirectly).⁵ The clinical features typically develop rapidly after injury and resolve

TABLE 1. SUMMARY OF COMPLICATIONS AND ADVERSE OUTCOMES ASSOCIATED WITH CONCUSSION IN SPORT

Complication	Comments	Evidence/anecdotal reports
Impaired performance and increased injury risk 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	Anecdotal reports ¹⁰ Increased risk of repeat concussion after an initial injury ¹¹
Acute, progressive diffuse cerebral oedema	Also referred to as 'second impact syndrome' due to a possible association with repeated head trauma Typically occurs rapidly after single head impact in most published cases ¹² Pathophysiology may involve disordered autoregulation	Case reports ¹³
Prolonged symptoms	Symptoms of concussion typically resolve spontaneously over a period of 10 to 14 days	Long recognised complication of mild traumatic brain injury ¹⁴ Prospective cohort studies monitoring clinical recovery following concussion demonstrate 5 to 10% of concussed athletes take longer than 10 days to recover and <1% have true 'postconcussion syndrome' (i.e. symptoms lasting >3 months) ^{8,9}
Depression and other mental health issues	Link demonstrated between head injury and risk of clinical depression later in life	Cross-sectional study in retired football players demonstrate a two to three times increase in relative risk of clinical depression ¹⁵
Cumulative cognitive deficits ('chronic traumatic encephalopathy')	Recurrent head trauma has been implicated in progressive deterioration in brain function May be related to genetic predisposition	Cross-sectional studies reporting lower cognitive performance in subjects with previous concussions compared with controls ¹⁶ Some athletes demonstrate persistent cognitive deficits postconcussion ¹⁷ Case reports of chronic traumatic encephalopathy in elite American football players ¹⁸

spontaneously over a sequential course. The pathophysiology remains poorly understood; however, the current consensus is that concussion reflects a disturbance of brain function rather than a structural injury.⁵⁻⁷

WHAT ARE THE POTENTIAL COMPLICATIONS?

In most cases of concussion in sport, clinical features resolve within 14 days of injury;⁸⁻⁹ however, a number of complications or adverse outcomes, including prolonged symptoms or cognitive deficits, depression and cumulative deterioration in brain function, have

been reported (Table 1).⁸⁻¹⁸

Risk factors for complications or adverse outcomes remain unclear. Although there is a suggestion that genetic factors play an important role,¹⁹ the current expert consensus is that premature return to play (and subsequent second injury before the individual has fully recovered from the initial concussion) may predispose to poorer outcomes following a concussive injury.⁷

HOW DO WE MANAGE CONCUSSION?

In clinical practice the important components of management of concussion in sport include confirming the diagnosis

(which includes differentiating concussion from other pathologies, in particular structural head injuries) and determining when players have fully recovered so that they can safely return to competition.

The latest consensus statement on the management of concussion in sport includes a comprehensive Standardised Concussion Assessment Tool (SCAT2) to facilitate assessment of athletes following a concussive injury.⁷ The SCAT2 and pocket SCAT are available online at: http://bjsm.bmj.com/content/43/Suppl_1/i85.full.pdf and http://bjsm.bmj.com/content/43/Suppl_1/i89.full.pdf. The tool contains a detailed graded symptom

TABLE 2. GRADUATED RETURN TO PLAY PROTOCOL⁷

Rehabilitation stage	Functional exercise	Objective
No activity	Complete physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% maximum predicted heart rate No resistance training	Increase heart rate
Sport-specific exercise	Light training drills (e.g. running, ball work, etc) No head impact activities	Add movement
Noncontact training drills	Progression to more complex training drills May start progressive resistance training	Exercise, co-ordination and cognitive load
Return to play	Normal game play	

checklist, tests of physical and cognitive function that are commonly affected following concussion and a section on athlete information and concussion injury advice. On initial examination, the tool can be used to help confirm the diagnosis of concussion, to document symptoms and to balance deficits and cognitive impairment in the patient. Use of the SCAT2 should also be repeated at follow up to monitor for recovery after injury.

CONFIRMING THE DIAGNOSIS

The clinical history is most important in making a diagnosis of concussion. 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. The diagnosis should be suspected in any patient who presents with any of these symptoms following a collision or direct trauma to the head. Clinical features that are more specific to a diagnosis of concussion include loss of consciousness, confusion or attention deficit, and memory and balance disturbance, although these 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' following trauma, is strongly suggestive of a concussive injury.

Use of a graded symptom checklist is often helpful (see the first part of SCAT2).⁷ The advantages of the symptom checklist are that it covers the range of symptoms and provides a measure of symptom severity.

DIFFERENTIATING CONCUSSION FROM STRUCTURAL PATHOLOGIES

Clinical features that may raise concerns of structural head injury include those listed below.

- The mechanism of injury, particularly if high speeds, falls from height or high velocity projectiles (e.g. baseball or cricket ball) are involved
- Progression of clinical features over time. Clinical features of concussion typically improve over time. Any deterioration in clinical state, in particular worsening headache, nausea or vomiting, or deterioration in conscious state, should raise suspicion of a structural head injury and warrant further investigation. Similarly, structural head injury should be kept in mind in any case in which symptoms persist beyond 10 to 14 days
- Finding of any focal neurological deficit on clinical examination.

Conventional imaging techniques such as x-ray, computerised tomography and magnetic resonance imaging are typically normal following acute concussion. The use of these investigations should be limited to excluding structural pathology.

DETERMINING WHEN PATIENTS CAN RETURN SAFELY TO COMPETITION

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.⁵⁻⁷ Currently, however, there is no single gold-standard measure of brain disturbance and recovery following concussion. Instead, clinicians must rely on indirect measures to inform clinical judgment. In practical terms this involves a comprehensive clinical approach, including:

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

TABLE 3. CONCUSSION MODIFIERS⁷

Factors	Modifier (may affect symptom duration or outcome)
Symptoms	High number, long duration (>10 days), high severity
Signs	Prolonged loss of consciousness (>1 minute), 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 old)
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

* Convulsive convulsions or impact seizures are occasionally observed following concussion in sport. These are usually brief in duration (less than one minute) and range from tonic posturing to full tonic-clonic seizures. Brief convulsive convulsions are benign, with no adverse clinical outcomes.²² Consequently, investigations are not required, antiepileptic treatment is not indicated and prolonged absence from sport is not warranted in the majority of cases.^{23,24}

Period of cognitive and physical rest to facilitate recovery

Early rest is important to allow recovery following a concussive injury. Physical activity, physiological stress (e.g. being at high altitude and flying) and cognitive loads (e.g. school work, videogames, computer) can all worsen symptoms and possibly delay recovery following concussion.⁷ Individuals should be advised to rest from these activities in the early stages after a concussive injury, especially while symptomatic (see concussion injury advice on page 4 of SCAT2).⁷ 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 also be given on avoiding activities that place the individual at risk of further injury (e.g. driving).⁷

Monitoring for recovery of postconcussion symptoms and signs

Monitoring of postconcussion symptoms and signs can be facilitated by use of the SCAT2.⁷ Given that the SCAT2 has been designed as an overall assessment tool, some of its components (e.g. Maddocks Questions, Glasgow Coma Score) are most useful in the acute setting following a concussive injury. The most important components of the tool for follow up include the graded symptom checklist, clinical tests of balance and cognitive assessment.

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.

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, and allows detection of cognitive deficits that have been observed to outlast symptoms in many cases of concussion.²⁰

There are a number of levels of complexity of cognitive testing, including:

- formal neuropsychological testing
- screening computerised cognitive test batteries
- basic paper and pencil evaluation (e.g. SCAT2).

Formal neuropsychological testing remains the clinical standard for the assessment of cognitive function. It is recommended if there is uncertainty about recovery or in difficult cases (e.g. prolonged recovery).

Screening computerised cognitive tests provide a practical alternative for the assessment of cognitive recovery. Ideally, the tests should be compared with the individual's own preinjury baseline. If a baseline does not exist, which is often the case in general practice, the test result can be compared with population normative data. In these cases, the test should be repeated until the individual's performance has stabilised. Moreover, this approach should be combined with a more conservative return to play plan.

A number of screening computerised cognitive test batteries have been validated for use following concussion in sport and are readily available. These include test platforms such as CogState Sport (www.cogstate.com/go/Sport) or ImPACT (www.impacttest.com).

If the concussion has resulted in brief symptoms and the player has recovered well clinically, basic paper and pencil cognitive tests can be used to provide an estimate of cognitive function (e.g. SCAT2). As above, 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.

Graduated return to activity

Following a concussive injury, players should return to play in a graded fashion (Table 2) once clinical features have resolved and cognitive function returned to 'normal' on neuropsychological testing. Overall, a more conservative approach (i.e. longer time to return to sport) should be used if 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. Players should be instructed that if any symptoms recur while progressing through their return to play program they should drop back to the previous asymptomatic level and try to progress again after a further 24-hour period of rest.

MODIFYING FACTORS AND THEIR IMPACT ON MANAGEMENT

At the most recent International Conference on Concussion in Sport in Switzerland (2008) a range of clinical factors that may be associated with longer duration of symptoms or increased risk of adverse outcomes following concussive injury were identified.²¹ These 'modifying' factors are summarised in Table 3.^{7,22-24} The presence of any modifying factor after a concussive injury dictates that a more conservative approach, including more detailed assessment and slower time to return to sport, is warranted. Consideration should also be given to a multidisciplinary team approach

(including referral to a neuropsychologist and/or doctor with expertise in managing concussive injuries).

SUMMARY

Concussion in sport reflects a functional disturbance rather than a structural injury to the brain. Although most individuals recover uneventfully following a concussive injury, complications and adverse outcomes 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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COMPETING INTERESTS: None